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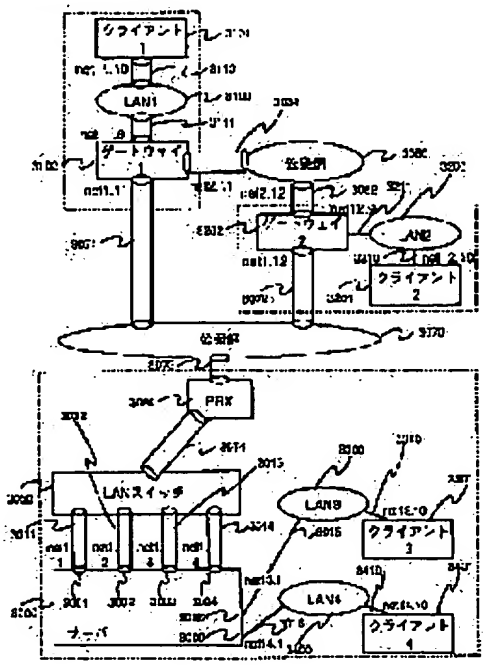
(54) NETWORK CONNECTION SYSTEM AND PARALLEL NETWORK CONNECTION METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To attain high speed parallel communication with high efficiency by selecting one communication channel among plural bands capable of plural band area reservation from a server computer in response to the service quality (QOS) from a client computer.
SOLUTION: In this case of data communication of a server 3000 with a client 3101, any of plural paths is selected. In the case of selecting a network interface, the server 3000 references a routing table, a network interface information table and a QOS management table. In response to a load of a QOS and the server 3000 requested by the client 3101, the server 3000 selects a network interface matching the condition among the plural network interfaces for data communication. Furthermore, the client 3101 uses the network interface in response to the QOS requested by a client to establish the connection for data communication.



CLAIMS

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[Claim(s)]

[Claim 1] A network connection system characterized by having a selection means to choose from said server computer one of the channels in which two or more band reservation is possible from a server computer through a network connection means connected to a network in a network connection system which performs data communication to a client computer according to a quality of service (QOS) from said client computer.

[Claim 2] In claim 1 publication, a LAN switch is formed between said networks and said server computers. It connects with said server computer by two or more channels using a virtual channel in which two or more band reservation of said LAN switch is possible. Said selection means The network address to which said client computer in the routing table is connected using a routing table in said server computer, By asking for a network address of said network connection means to send out a packet, using the address of a network interface of said server computer corresponding to said two or more channels A network connection system characterized by choosing a different channel.

[Claim 3] It is the network network connection system characterized by said LAN switch consisting of ATM switches in claim 2 publication.

[Claim 4] It is the network connection system characterized by said network connection means consisting of Gateway computers in claim 1 publication.

[Claim 5] A network connection system characterized by preparing a QOS managed table which holds a band of a virtual channel, and statistical information of a dynamic load for said every network interface in said server computer in claim 2 publication, and referring to this table QOS managed table to an establishment demand of a channel.

[Claim 6] It is the network connection system characterized by constituting from three items of a service feature class and a peak bandwidth (Mbps) which consist of three kinds of GSs (Guaranteed Stream) which are the communication links of stream data, such as BE (Best Effort) said whose quality of service (QOS) is the usual data communication in claim 1 or five publications, GB (Guaranteed Burst) which is the data communication for burst transmission, video, and voice, and an average bandwidth (Mbps).

[Claim 7] In a computer which is equipped with two or more network interfaces, and performs an alien machine and network communication To said computer, a final destination network address of a packet, and the address of said network interface, It has routing table which holds a network address of the gateway which is the next receiver's address of a packet called for from both address to each entry. A computer characterized by choosing at least one network interface and sending a packet to the above-mentioned Gateway from a selected network interface.

[Claim 8] Said computer is equipped with a quality-of-service (QOS) maintenance means to hold each operating condition of said network interface, in claim 7 publication. When choosing said network interface A final destination network address chooses at least one entry equal to a network address of said alien machine from entries of said routing table. It is based on a result of having compared the above-mentioned QOS maintenance means of a network interface shown in the address of a network interface of an entry of selected routing table. A computer characterized by choosing at least one network interface.

[Claim 9] When requiring that said alien machine should establish a channel to said computer in claim 8 publication As opposed to assignment of a QOS parameter which was specified from said alien machine and which consists of a service feature class, average traffic, and peak traffic of a channel said computer A final destination network address chooses at least one entry equal to a network address of said alien machine from entries of said routing table. Said QOS maintenance means and said QOS parameter of a network interface shown in the address of a network interface of an entry of selected routing table are compared. A computer characterized by choosing at least one network interface so

routing table are compared. A computer characterized by choosing at least one network interface so that conditions specified with said QOS parameter can be fulfilled.
[Claim 10] A computer characterized by sending the address of a network interface of said at least one network interface which was made to accompany a synchronous (SYN) packet which transmits at the time of establishment of a channel, and said computer chose to said alien machine in claim 8 publication when said alien machine and said computer establish a channel.
[Claim 11] It has a LAN switch which bundles two or more 1st channels by which said computer is connected to said two or more network interfaces to the 2nd channel, and sends them to a public network in claim 8 publication. Said LAN switch is equipped with a switching maintenance means to specify switching with the 1st channel and the 2nd channel. When the 1st channel which said computer chose differs from the 1st channel specified by said alien machine A computer characterized by what is directed on said LAN switch so that said 1st computer may become the 1st channel as which said 1st computer chose said switching maintenance means.
[Claim 12] It has the 1st computer equipped with two or more network interfaces, and the 2nd computer connected to a network through a Gateway computer. In case network communication is performed, to said 1st computer A final destination network address of a packet, Ask from the address of said network interface, and both address. It has routing table which holds a network address of a gateway computer which is the next receiver's address of a packet to each entry. Said 1st computer A juxtaposition network connection method characterized by choosing at least one network interface and sending a packet to the above-mentioned Gateway from a selected network interface.
[Claim 13] When said 2nd computer requires establishment of a channel from said 1st computer in claim 12 publication, Said 1st computer chooses at least one entry with a final destination network address equal to a network address of the 2nd computer from entries of routing table. A QOS parameter specified by a QOS maintenance means and said 2nd computer of a network interface shown in the network interface address of an entry of selected routing table is compared. At least one network interface is chosen so that conditions specified with a QOS parameter can be fulfilled. Said 1st computer is the juxtaposition network connection method characterized by sending a packet to the gateway through the network interface.
[Claim 14] It is the juxtaposition network connection method characterized by teaching a network address of all network interfaces that were made to accompany a synchronous (SYN) packet which transmits said 1st computer to said 2nd computer in claim 12 publication at the time of establishment of a channel, and were chosen.
[Claim 15] A juxtaposition network connection method characterized by using two or more network interfaces of said 1st computer for juxtaposition, and performing data communication in claim 12 publication in the case of the 2nd computer equipped with a large network interface of a band.

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[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to the network connection system by which to respond to various qualities of service (QOS) like an ATM network especially is demanded about the network connection system and the juxtaposition network connection method of a computer equipped with two or more network interfaces.

[0002]

[Description of the Prior Art] The conventional network connection in the server which equipped drawing 15 with two or more network interfaces is shown. As a server equipped with two or more network interfaces, the NFS server of Auspex and the storage server of Maximum Strategy are known, for example.

[0003] In drawing 15 , the network where a network interface and 505 are connected to routing table, and 510, 520, and 530 are connected [500] to network interfaces 501, 502, and 503 for a server, and 501, 502 and 503, respectively, 511 or 513 and 521 523 and 531 thru/or 533 show the clients (a workstation, PC, etc.) connected to networks 510, 520, and 530, respectively. The network where 540 is connected to a public network 570, and 541 show the client connected to a network 540. In addition, the network interface with which a server is equipped consists of cards, related software, etc. for an interface as substance.

[0004] A server 500 is connected with a public network 570 through the gateway 550 and PBX (Private Branch Exchange: private branch exchange)560 which were connected to the network 510. The network address net 1.1 of a network 510, net 1.2, and net1.3 are assigned to clients 511, 512, and 513, respectively, and the network address net1.11 of a network 510 is assigned to the network interface 501. Only by using net1.11 (i.e., only [clients 511, 512, and 513 let a network 510 pass]), they can perform a server 500 and data communication. Similarly, clients 521, 522, and 523 perform a server 500 and data communication through a network 520, and clients 531, 532, and 533 perform a server 500 and data communication through a network 530. The client 541 connected to the public network 570 performs a server 500 and data communication via PBX560, the gateway 550, and a network 510. Only by the client connected to LAN1-LAN3 leading the networks 510, 520, and 530 connected beforehand, it can perform data communication.

[0005] When transmitting data to clients 511, 512, and 513, clients 521, 522, and 523, or clients 531, 532, and 533 from a server 500, according to assignment of the routing table 505 which the operating system of a server 500 manages, any one of the network interfaces 501, 502, and 503 (networks 510, 520, and 530) is used. On the other hand, when transmitting data to a client 541 from a server 500, according to assignment of routing table 505, Gateway 550 connected to the network 510 is chosen, and Gateway 550 sends the packet sent from the server 500 to a network 540. In this case, only a network interface 501 will be used.

[0006] The configuration of the conventional routing table is shown in drawing 2 . In drawing 2 , 161

[0006] The configuration of the conventional routing table is shown in drawing 2 . In drawing 2 , 161 thru/or 165 show the item of the entry of routing table. Each entry is connected to the line type list which uses as a header the entry 100 which becomes settled in the value which changed the destination address by Hash Function 180 thru/or 150. A destination address is used as a key, a line type list is followed, and the entry whose destination address 161 corresponds with a key is found. A packet is sent out from the gateway address 162 which is a network address of the entry found first. For example, in drawing 15 , it can communicate with a client 541 through a network interface 501 from a server 500 using the network 510 connected to the gateway 550. (When communicating with each client connected to networks 510, 520, and 530 through the network interfaces 501, 502, and 503 of a server 500 in addition, a network address net 1.11, net 2.11, and net3.11 will be directly specified instead of the Gateway address 162.)
The details of routing table are "Internetworkingwith TCP/IP, Volume I and II" (Prentice Hall) of work besides Douglas E.Comer, and "TheDesign and Implementation of the 4.3 BSD UNIX Operating system" (AddisonWesley) of work besides S.J.Leffler. It is shown. Thus, the role of routing table is in the point which uses the destination address of a packet as a key and clarifies network addresses, such as the gateway which sends out this packet next.
[0007] Furthermore, the information 171 about the network interface which arrives at the gateway thru/or 176 can be obtained with the pointer 163 to the entry of the network interface information table in a routing table entry. As information about a network interface, there are 173 and 174 input / output packets which passed the maximum transfer length (MTU: Maximum Transmission Unit) 172 of a network interface and this network interface.
[0008]
[Problem(s) to be Solved by the Invention] According to the above-mentioned conventional technology, by the data communication of a client and a server, although two or more network interfaces of a server exist, since only only one network interface to which the client is connected was used, according to the load profile initiation of a network interface, the network interface was chosen dynamically, and there was a problem that a load could not be distributed. This leads to the problem that the various qualities of service (QOS) of a client cannot be answered. For example, although the needs which communicate multimedia data, such as voice, an image, and data, were increasing these days, since capacity became quite large, it was difficult [it] to fill the quality of service (QOS) which a load concentrates on one network interface and a client requires.
[0009] Furthermore, according to the above-mentioned conventional technology, when the bandwidth of the network interface of a client was larger than the bandwidth of each network interface of a server, there was a problem that the network interface used for the transfer to a client from a server could not fully utilize the bandwidth of the network interface of a client since even free is restricted.
[0010] The purpose of this invention solves the above-mentioned technical problem, and using the network interface according to the quality of service (QOS) which a client requires in the server equipped with two or more network interfaces, it communicates or it is to offer the network connection system and the juxtaposition network connection method of communicating by using two or more network interfaces for juxtaposition.
[0011] Moreover, it connects with the server which has two or more network interfaces using the network which can reserve a band like an ATM network, and other purposes of this invention are to offer the network connection system and the juxtaposition network connection method of using the network interface which fills the quality of service (QOS) which a client requires at the time of connection establishment.
[0012]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention holds the network interface address which is the address of a network interface to each entry of routing table of the 1st computer (server).
[0013] Moreover, it has a quality-of-service (QOS) maintenance means to hold an operating condition

[0013] Moreover, it has a quality-of-service (QOS) maintenance means to hold an operating condition of each network interface. Furthermore, it has a means to specify a QOS parameter specified when the 2nd computer (client) establishes the 1st computer and channel. When the 2nd computer (client) specifically requires establishment of a channel from the 1st computer (server), The 1st computer chooses at least one entry with a final destination network address equal to a network address of the 2nd computer from entries of routing table. A QOS parameter specified by a QOS maintenance means and the 2nd computer of a network interface shown in the network interface address of an entry of selected routing table is compared. At least one network interface is chosen and the 1st computer sends a packet to the gateway through the network interface so that conditions specified with a QOS parameter can be fulfilled. Moreover, the 1st computer is made to accompany a synchronous (SYN) packet which transmits at the time of establishment of a channel to the 2nd computer, and a network address of all selected network interfaces is taught.

[0014] Moreover, in the case of the 2nd computer equipped with a large network interface of a band, it constitutes so that two or more network interfaces of the 1st computer may be used for juxtaposition and data communication can be performed.

[0015] When a client performs a server and data communication equipped with two or more network interfaces, it is desirable for a server to be able to choose a network interface according to magnitude of a dynamic load of each network interface etc. so that a quality of service (QOS:Quality of Service) which a client requires can be filled.

[0016] In this invention, in order that a server may enable it to perform data communication to the same client first using a different network interface, it supposes that a virtual channel in which two or more band reservation of a LAN switch like an ATM (Asynchronous Transfer Mode) switch is possible is used, and the address of a network interface is added to the conventional routing table entry. It enables it to choose a different path by asking for a network address of a client, and a network address of the gateway which sends out a packet by both of the network interface address.

[0017] Furthermore, a QOS managed table which holds a band of a virtual channel and statistical information of a dynamic load for every network interface is prepared in the (a) server. With reference to this table entry, extend 3 way handshake of (b) former to an establishment demand of a data communication way, and it sets at the time of connection establishment. When a server returns SYN (synchronization)/ACK (response) to a client A connection's network interface address which a server chose as a parameter of SYN is attached. A client establishes a connection using a network interface which a server chose, and enables it to perform subsequent data communication by returning ACK to the network interface address specified by SYN. moreover, in the case of a client equipped with a large network interface of a band In order to use two or more network interfaces of a server for juxtaposition and to enable it to perform data communication When a server returns SYN/ACK to a client at the time of connection establishment by 3 way handshake The number of network interfaces which a server chose as a parameter of SYN, and each network address are attached. A client returns ACK to all network addresses specified by SYN, establishes a connection using a network interface which a server chose, and enables it to perform subsequent data communication. Furthermore, it enables it to realize parallel communication without modification of an application program by performing division and integration of a packet between a protocol layer and the application layer.

[0018]

[Embodiment of the Invention]

(1) Explain one or less example of an operation gestalt, and the detailed example of an operation gestalt of this invention.

[0019] Drawing 3 shows the whole network connection system block diagram concerning the example 1 of an operation gestalt of this invention. In drawing 3 , as for PBX (Private Branch eXchange: private branch exchange) and 3070, the server computer by which, as for 3000, this invention is applied, a LAN switch [like for example, an ATM (Asynchronous Transfer Mode) switch] whose 3050 is, and 3060 show a client computer and the gateway computer by which, as for LAN (Local Area Network),

3060 show a client computer and the gateway computer by which, as for LAN (Local Area Network), and 3101, 3201, 3301 and 3401, 3102 are applied, and, as for 3202, this invention is applied, as for a public network, and 3100, 3200, 3300 and 3400.

[0020] A server 3000 consists of a single computer or single parallel computers, such as a workstation, and it lets network interfaces 3001, 3002, 3003, and 3004 pass, and connects with channels 3011, 3012, 3013, and 3014, respectively, and these channels are connected with the LAN switch 3050. Moreover, it lets network interfaces 3005 and 3006 pass, and connects with channels 3015 and 3016, and these channels are connected with LANs 3300 and 3400, respectively. The LAN switch 3050 consists of switches like an ATM switch or a Fibre Channel, and is connected with PBX3060 through a channel 3074, and PBX3060 is connected to a public network 3070 through a channel 3073. Here, channels 3011, 3012, 3013, 3014, 3074, and 3073 consist of virtual channels in which one or two or more band reservation are possible like ATM, respectively, and the LAN switch 3050 and PBX3060 perform switching between virtual channels. It is the point to have two or more virtual channels between a LAN switch and a server. Clients 3101, 3201, 3301, and 3401 Consist of computers, such as PC and a workstation, and it connects with LANs 3100, 3200, 3300, and 3400 through channels 3110, 3210, 3310, and 3410, respectively. The gateway 3102 is a computer for carrying out network connection, and lets channels 3111, 3071, and 3081 pass. Connect with LAN3100, a public network 3070, and a public network 3080, respectively, and are a computer for similarly carrying out network connection also of the gateway 3202, and it lets channels 3211, 3072, and 3082 pass. It connects with LAN3200, a public network 3070, and a public network 3080, respectively. In addition, as a network connection means, a router, a switch, etc. are included other than Gateway.

[0021] In this example of an operation gestalt, net1.* is assigned to the network containing the LAN switch 3050 and a public network 3070 as a network address, and net11.*, net12.*, net13.*, and net14.* are assigned to net2.*, and LAN1, LAN2, LAN3 and LAN4 in the network containing a public network 3080, respectively. In the network interface 3001 of the server 3000 to which a channel 3011 thru/or 3016 are connected thru/or 3006 Network addresses net1.1, net1.2, net1.3, net1.4, net13.1, and net14.1 are assigned, respectively. To clients 3101, 3201, 3301, and 3401 Respectively to each network interface of net11.10, net12.10, net13.10, net14.10, and the gateway 3102 net12.9, net1.12, and net2.12 are assigned to each network interface of net11.9, net1.11, net2.11, and the gateway 3202.

[0022] In drawing 3 , a server 3000 can choose two or more paths, when performing a client 3101 and data communication. Even if a server 3000 uses any of network interfaces 3001, 3002, 3003, and 3004, the communication link of it is possible with a client 3101 through the LAN switch 3050, PBX3060, a public network 3070, the gateway 3102, and LAN3100. Moreover, there is a path which passes through the gateway 3202, a public network 3080, the gateway 3102, and LAN3100 as other paths from a public network 3070 to a client 3101.

[0023] Now, the example 1 of an operation gestalt of this invention is explained using the case where a client 3101 performs connection-oriented data communication using a server 3000 and a TCP/IP protocol. First, the example of an operation gestalt of programme description is shown in drawing 16 . This program is "UNIX network programming" written by W.D.Stevens (Prentice Hall). The program using socket currently described is extended. The program by which 9001 to 9015 is performed by the server 3000 is shown, and the program by which 9050 to 9061 is performed by the client 3101 is shown. A server 3000 waits for the connection establishment demand from the client (9004) of arbitration by listen() call, after performing generation (9002) of socket, and address attachment (9006) of socket (9007). After a client 3101 generates socket (9053), it specifies net1.1 (9051) which is one of the network addresses of a server 3000 (9055), and requires connection establishment with a server by connect() call (9058).

[0024] QOS of a channel is specified when requiring connection establishment with a server (9057). QOS consists of three items of a service feature class, a peak bandwidth (Mbps), and an average bandwidth (Mbps), as shown in 9052. In a service feature class, it is Best Effort. There are three kinds, (BE), GB (Guaranteed Burst), and GS (Guaranteed Stream). BE is the usual data communication and a

(BE), GB (Guaranteed Burst), and GS (Guaranteed Stream). BE is the usual data communication and a data throughput changes according to the lump condition of a channel. GB is the data communication for burst transmission, and guarantees the throughput at the time of burst transmission as much as possible. Reservation of a band can also be made to fluctuate before burst transmission initiation. GS is the communication link of stream data, such as video and voice, and guarantees the bandwidth secured beforehand. Service feature class assignment can also be turned OFF.

[0025] If a client 3101 requires establishment of a channel by conncet() call and a server 3000 accepts the demand of a client, the channel between a client and a server will be established by accept() call (9009). A server assigns the descriptor newfd of the socket used by the newly established channel (9009), a child process is generated (9010), and data communication is performed between a child process and a client (9013). A parent process returns to a waiting state so that it may receive the demand from other clients (9015 9008). A channel's establishment of a client 3101 performs data communication between servers (9059). (9058)

[0026] Next, the example of an operation gestalt of the establishment method of the connection between the clients 3101 and servers 3000 in a TCP/IP protocol layer is shown using drawing 4 , drawing 1 , drawing 9 , drawing 10 , drawing 11 , and drawing 12 .

[0027] First, the outline of processing of the connection establishment method is shown using drawing 4 . In drawing 4 , 3500, 3501, 3502, 3503, 3550, 3551, and 3552 show the condition of a TCP protocol, and 3570, 3571, and 3572 show 3 way handshake which establishes a connection between a client 3101 and a server 3000. Original 3 way handshake is described in detail at "Internetworking with TCP/IP, Volume I, and II" (Prentice Hall) of work besides DouglasE.Comer.

[0028] If the listen() call in the program shown in drawing 16 is performed (9007), the server 3000 of a CLOSED condition (3500) will be in a LISTEN condition, and will wait for the connection open request from a client (3501). The client 3101 of the CLOSED condition 3550 will create control-block TCB (Transmission Control Block) required in order to control data communication with the network address net1.1 which is one of the network interfaces of a server 3000, if the connect() call in the program shown in drawing 16 is performed (9058) (3560). Next, in order to require connection establishment from net1.1, the TCP packet which set (3561) and an SYN (synchronization) flag is sent to a server 3000. At this time, a client 3101 sends a connection's QOS (quality of service) to a server 3000 as a parameter of a TCP packet with an SYN flag (3570). QOS consists of three items of a class of service, a peak bandwidth (Mbps), and an average bandwidth (Mbps), as shown in 9052 of drawing 16 . A client 3101 is SYN when a TCP packet with an SYN flag is sent. It will be in a SENT condition (3551).

[0029] The server 3000 of a LISTEN condition will look for the network interface which fills QOS of a client 3101, if a TCP packet with QOS (quality of service) is received. The example of an operation gestalt of the procedure which chooses a network interface is mentioned later. The case where the network interface 3003 in drawing 3 and the interface of a network address net1.3 are chosen now is described (3510). A server 3000 creates TCB (Transmission Control Block) corresponding to a network address net1.3 (3511). The network address of a client 3101, the network address net1.3 of the network interface with which the server 3000 was chosen, and the communications protocol name TCP are held at TCB. A server 3000 is SYN about delivery (3571) and this TCB to a client 3101 in the TCP packet to which the ACK (response) flag to SYN from a client was attached to the client 3101 after creating TCB, and the TCP packet to which the SYN flag was attached. It changes into a RECVD condition (3502). A network address net1.3 is attached to an SYN flag as a parameter. If the TCP packet with an SYN flag which accompanied network address net1.3 as a parameter is received, a client 3101 will delete TCB created to net1.1 (3562), and will create TCB corresponding to net1.3 (3563). Next, a client 3101 will be in delivery (3572) and an ESTABLISHED condition about a TCP packet with an ACK flag to net11.3 (3552). If a server 3000 also receives ACK, it will be in an ESTABLISHED condition (3503), and the communication link by SEND/RECEIVE can be henceforth

ESTABLISHED condition (3503), and the communication link by SEND/RECEIVE can be henceforth performed between a client and a server (3573).

[0030] The details of the connection establishment method of this invention shown using drawing 4 above are explained using drawing 1 , drawing 9 , drawing 10 , drawing 11 , and drawing 12 . When flow chart drawing of processing of the server 3000 after the condition that drawing 9 , drawing 10 , and drawing 11 are waiting for the connection establishment demand from a client in the state of LISTEN (3501), and drawing 12 choose flow chart drawing of processing of a client 3101 and drawing 1 chooses a network interface, the data structure to be used is shown.

[0031] In drawing 9 , if the TCP packet to which the SYN flag with QOS assignment was attached from the client 3101 is received (3570), the server 3000 of a LISTEN condition (3501) fills the QOS demand of a client 3101, and it will perform the following processings in order to choose the network interface which can distribute the load of the network interface of a server 3000 (4010).

[0032] The procedure which chooses a network interface is explained using drawing 1 together. Drawing 1 shows the routing table concerning the example 1 of an operation gestalt of this invention, a network interface information table, and a QOS managed table. When you choose a network interface, refer to these tables for a server 3000.

[0033] In drawing 1 , 10 thru/or 60 are the headers of the list of each entry of routing table. The network address (destination address when it sees from a server 3000) net11.10 of a client 3101 is changed by the Hash Function, and a routing table entry is followed. Each entry of routing table In order to reach to the destination address 70 of the client which is the point which finally sends a packet, the network address 71 of the network interface of the server 3000 which can reach to a destination address, and a destination address 70 Next, a packet The network address 72 of the gateway to send out, the pointer 73 to the network interface information table holding the information on a network interface and the QOS information on a network interface that the gateway is connected, It consists of a pointer 75 for creating the pointer 74 for the destination searching an equal routing table entry at a high speed, and the list of routing table entries, and other 76. Each entry of a network interface information table It lets the identifier 80 of a network interface, the maximum packet size (MTU:Maximum Transmission Unit) 81 which can process the network interface concerned, and the network interface concerned pass. The accumulation value of the number of packets transmitted and received 82 receive packets and 83 transmitting packets to hold, It consists of a pointer 84 for creating the line type list of entries of a network interface information table, a pointer 85 to the QOS managed table entry holding the QOS information and dynamic load information on the network interface concerned, and other 86. Each entry of a QOS managed table The maximum bandwidth of the network interface concerned (Megabits per second) Whether the connection of the number 91 of 90 and a virtual channel (VC), the bandwidth (bandwidth) (megabits per second) 92 currently assigned to each virtual channel, and each virtual channel is established A connection is established for the shown flag 93, the virtual channel number 94 from which the connection is established for the class of service by GB or GS, and a class of service by GB or GS. It consists of the total value (megabits per second) 95 of the bandwidth which is reserved, the amount 96 of peak transfers for [newest] 1 minute (megabits per second), the amount 97 of average transfers for [newest] 1 minute (megabits per second), etc.

[0034] The example of an operation gestalt of the whole routing table of a server 3000 in the network connection configuration of drawing 3 is shown using drawing 13 . In drawing 13 , each of the whole routing table, 3801, or 3814 shows [3800] the destination address in a routing table entry (70), the network address (71) of a network interface, and the network address (72) of the gateway.

[0035] Destination address net11.* (3801 thru/or 3808) shows the network address of LAN3100 containing a client 3101, and destination address net12.* (3809 thru/or 3812), net13.* (3813), and net14.* (3814) show each network address of LANs 3200, 3300, and 3400. The entry 3801 shows that routing to net11.* is possible at gateway 3102 (network address net1.11) course using the network interface 3001 (a network address is net1.1) of a server 3000. Similarly entries 3802, 3803, and 3804

interface 3001 (a network address is net1.1) of a server 3000. Similarly entries 3802, 3803, and 3804 Network interfaces 3002, 3003, and 3004 (a network address is net [1.2], net [1.3], and net1.4) are used, respectively. Gateway 3102 course shows that routing to net11.* is possible. Entries 3805, 3806, 3807, and 3808 Network interfaces 3001, 3002, 3003, and 3004 (a network address is net [1.1], net [1.2], net [1.3], and net1.4) are used, respectively. Gateway 3202 (network address net1.12) course shows that routing to net11.* is possible. As mentioned above, the network interface and the gateway address which can reach to net11.* beforehand are set as routing table, and a data communication way (path) is chosen according to the load of the network interface of QOS or a server 3000 which a client 3101 requires, or the load of the LAN switch 3050 at the time of connection establishment. Similarly, entries 3809, 3810, 3811, and 3812 show that routing to net12.* is possible by gateway 3202 (network address net1.12) course using network interfaces 3001, 3002, 3003, and 3004 (a network address is net [1.1], net [1.2], net [1.3], and net1.4), respectively.

[0036] According to the setup of the routing table of drawing 13 , routing of gateway 3102 course is not made for gateway 3102 course to be also possible for routing to net12.* according to drawing 3 , but to perform. Since there is only the one number of the network interfaces of a server 3000 at a time as for routing to net13.* and net14.*, the network interface address of entries 3813 and 3814 is not specified because it is not necessary to specify. In addition, at the conventional routing table, there was no column of the network address of a network interface in routing table.

[0037] Establishment of a connection registers into a table 3820 the network address (transmitting agency address) of the network interface of the client (destination address) which performs data communication, and a server. In the case of the table 3820 of drawing 13 , the connection is established between a client 3101 and the network interfaces 3002, 3003, and 3004 of a server 3000 (3821, 3822, 3833).

[0038] It returns to explanation of drawing 9 . A server 3000 applies the network address net11.10 of a client 3101 to a Hash Function, and asks for the header 40 of the list of routing table entries (4020). A routing table entry is followed from a header 40, and the destination address 70 of the entry investigates whether it is equal to the network address net11.10 of a client 3101, or the subnetwork address net11 of a client 3101 (4030). When the address is an inequality, the pointer 75 to degree entry of a routing table entry is followed, and it progresses to the following entry (4035), and it repeats until the routing table entry of the destination address 70 equal to the network address net11.10 of a client 3101 or the subnetwork address net11 of a client 3101 is found (4030 4035).

[0039] The case where a routing table entry with the equal address is found is explained.

[0040] (A) From the pointer 73 in a routing table entry, in the case of GB (GuaranteedBurst) or GS (Guaranteed Stream), the service feature class which a client 3101 requires investigates a network interface information table entry (4040), and records the value of the pointer 85 to the QOS managed table entry in it on a work memory area (4050). Using the pointer 74 in a routing table entry, it asks for all the routing table entries of the same destination address (4060), and the value of the pointer 85 to the QOS managed table entry in the network interface information table entry is recorded on a work memory area (4050). In the case of this example of an operation gestalt, according to the routing table 3800 of drawing 13 , an entry 3801 thru/or eight entries of 3808 are chosen.

[0041] It moves to drawing 10 . Next, the pointer to the QOS managed table entry recorded by 4050 is followed, the record in a QOS managed table entry is investigated, and the network interface of a server 3000 which fulfills the following two conditions is chosen (4070).

[0042] 1) They are two conditions of thing ** in the bandwidth of a non-reserved virtual channel (93) with the peak bandwidth smaller than the greatest thing which the average bandwidth which a client's 3101 requires being smaller than the value which lengthened the sum total (95) of the maximum bandwidth (90) to a reserved bandwidth, and two clients 3101 require.

[0043] When there is no corresponding network interface, the amount of peak transfers for 1 minute (96) chooses the minimum network interface recently (4080). Although shown neither in drawing 10

(96) chooses the minimum network interface recently (4080). Although shown neither in drawing 10 nor drawing 4 , when the demand of a client 3101 cannot be filled A server 3100 is SYN. As opposed to the client 3101 of a SENT condition Tell the purport with which the demand of a client 3101 cannot be filled as a parameter of a TCP packet with an ACK flag, have deliberations of a client 3101 and QOS, and a client 3101 respecifies QOS. again -- a TCP packet with an SYN flag -- a server 3000 -- delivery (3570) and new QOS -- being based -- a server 3000 -- a network interface -- searching (3510) -- you may have deliberations between the servers 3000 and clients 3101 to say.

[0044] It returns to drawing 10 again, and in 4070, when there is a corresponding network interface, a reserved bandwidth chooses the minimum interface from the network interfaces which fulfill conditions (4085). The average bandwidth which the client 3101 is demanding is applied to the reserved bandwidth (95) of the QOS managed table entry of the selected network interface.

[0045] Below, a routing table entry including the address of the selected network interface is used.

[0046] (B) In BE (Best Effort) or un-specifying the service feature class which return and a client 3101 require of 4030, use the routing table entry found first.

[0047] It asks for the network address (71) of a network interface from the selected routing table entry (4200). TCB (Transmission control Block) required to perform data communication of End-to-End using a TCP protocol is created (4210). The network address for which it asked by 4200 is specified as the transmitting agency address described in TCB, and the network address of a client 3101 is specified as a destination address. When TCB is created, they are delivery (4220) and SYN about the TCP packet with an SYN flag which added the TCP packet with an ACK flag, and the network address of a network interface to the client 3101 as a parameter. It will be in a RECVD condition (3502).

[0048] It moves to drawing 11 . SYN In a RECVD condition, if a TCP packet with an ACK flag is received from a client 3101 (4250), the network interface address and the network address of a client 3101 concerned are registered into the managed table (table 3820 in drawing 13) of a connection establishment finishing channel (4260), and it will be in an ESTABLISHED condition (3503). Henceforth, data communication according to QOS is performed between a client and a server.

[0049] The detailed procedure of a client 3101 is shown using drawing 12 . the client of a CLOSED condition (3550) -- an application program -- one network address net1. in two or more network interfaces of a server 3000 -- A (9051) and QOS (9057) are specified and a connect() call is performed (9058). OS on a client receives a channel open request ignited by a connect() call (4300). OS creates TCB (Transmission Control Block) required for the communication link with net1.A first, and the TCP packet with an SYN flag which makes a parameter the QOS value specified by the connect() call is sent to addressing to net1.A which is one in the network interface of a server 3000 (4310). A client 3101 is SYN when a TCP packet with an SYN flag is sent. It will be in a SENT condition and will wait for the TCP packet with an ACK flag sent from a server 3000 (3551). If ACK and a TCP packet with an SYN flag are received, it will investigate whether network address net1.B which is the parameter of SYN and which is one of the addresses of the network interface of a server 3000 is equal to net1.A (4320). In being equal, it sends a TCP packet with an ACK flag to a server 3000 by addressing to net1.A (4345). In the case of an inequality, it is regarded as that by which the server 3000 changed the network interface, it deletes TCB for the communication link with net1.A created by 4310, and newly creates TCB for the communication link with net1.B (4330). A TCP packet with an ACK flag is sent to a server 3000 by addressing to net1.B after creating TCB (4340). If ACK is returned next, network address net1.B of the network interface of a server 3000 and the network address net11.10 of a client 3101 are registered into the connection establishment finishing channel managed table in a client (4350), and it will be in an ESTABLISHED condition (3552). Henceforth, data communication according to QOS is performed between a client and a server.

[0050] Next, actuation of the LAN switch 3050 in the connection establishment method is explained using drawing 7 and drawing 8 .

[0051] In drawing 7 , 3011, 3012, 3013, 3014, and 3074 express a channel as well as drawing 3 . 3011a

and 3011b show the virtual channel set as a channel 3011. In drawing 7 , on account of a drawing, although two virtual channels are only described, the virtual channel of usually much more numbers exists. Moreover, a virtual channel may be dynamically generated, although it may be set up beforehand. They are the virtual channel by which 3012a and 3012b are set as a channel 3012, the virtual channel by which 3013a and 3013b are set as a channel 3013, the virtual channel by which 3014a and 3014b are set as a channel 3014, and the virtual channel set as a channel 3074 3074a, 3074b, 3074c, 3074d, 3074e, and 3074f. In a channel 3074, the virtual channels 3074a (VC=11), 3074b (VC=12), 3074c (VC=13), and 3074d (VC=14) are connected to the virtual channel of a channel 3071, and the virtual channels 3074e (VC=21) and 3074f (VC=22) are connected to the virtual channel of a channel 3072.

[0052] In drawing 7 , it is the switching table showing how 5000 is connected to the translation table of the network address of each network interface of a server 3000, and the port number of the LAN switch 3050, and each port of the LAN switch 3050 and the group of a virtual channel are connected mutually, as for 5010 (a). With a translation table 5000, a network address can be changed into the physical address of the LAN switch 3050, and a packet can be sent out to the port specified at a network address. The switching table 5010 is a table set up when a connection is established. In drawing 7 , 5100, 5200, 5300, 5400, and 5500 show the entry of the QOS managed table of port #0 of the LAN switch 3050, #1, #2, #3, and #4. The format of each entry is the same as 90 of drawing 1 thru/or 97. If routing is carried out to which gateway in two or more gateways connected to the public network 3070 in drawing 3 when a server 3000 performs routing as the gateway, when a server 3000 also manages QOS of port #0 of the LAN switch 3050 and a server 3000 establishes a connection as a client, it can judge whether QOS of a client can be filled. that is, in the example of an operation gestalt described using drawing 9 , drawing 10 , and drawing 11 Although the path at the time of connection establishment with a client 3101 was determined from the QOS managed table entries 5110, 5120, 5130, and 5140 of network interfaces 3001, 3002, 3003, and 3004 Furthermore, the QOS managed table entry 5100 of port #0 of the LAN switch 3050 is also used together. The virtual channel of port #0 of the LAN switch 3050, A setup of switching of the virtual channel of port #1, and 2 and 3 can also be taken into consideration, and the path of a server 3000 and the LAN switch 3050 can be chosen. The procedure for the decision is the same as that of drawing 9 , drawing 10 , and drawing 11 .

[0053] Actuation of the LAN switch 3050 in the connection establishment method is explained using drawing 8 . The case (5500) where routing of the TCP packet with an SYN flag addressed to net1.1 of a server 3000 was carried out, and it reaches port #0 of the LAN switch 3050 and VC=11 (3074a) from a client 3101 is explained. The LAN switch 3050 investigates a translation table 5000, and asks for sending-out place port # of the TCP packet with an SYN flag addressed to net1.1 being 1 (5510). Next, VC=1 (3011a) is chosen from the virtual channels of port #1, and it registers with the address switching table 5010 (a) so that (port #0, VC=11), and (port #1, VC=1) may be switched mutually (5520). When a server 3000 chooses a channel 3013 (network address net1.3) as a network interface, now a server 3000 The entry which described correspondence of (port #1, VC=1) is made to delete. it registers with the address switching table 5010 to the LAN switch 3050 -- **** (port #0, VC=11) -- The entry which described correspondence of (port #3, VC=1) further (port #0, VC=11) is made to add (5530). The LAN switch 3050 changes the contents of the address switching table 5010 (a) (5540). As a result of modification, a table 5010 (a) is updated as shown in a table 5010 (b). Consequently, a server 3000 can send a TCP packet with an ACK flag, and the TCP packet with an SYN flag which the network address net1.3 accompanied as a parameter to a client 3101 using a channel 3013 (5550). that is, the time of a client 3101 sending a TCP packet with an SYN flag to a server 3000, as for the packet which the server 3000 sent out to (port #3, VC=1) -- having used it (port #0, VC=11) -- since it is switched, it not only can reach a client 3101, but it can use the path established even from the client 3010 to the LAN switch 3050 as it is. a client 3101 -- a server 3000 -- receiving -- the network address net1.3 from (port #0, VC=11) -- corresponding (port #3, VC=1) -- a TCP packet with an ACK flag is

net1.3 from (port #0, VC=11) -- corresponding (port #3, VC=1) -- a TCP packet with an ACK flag is sent out (5560), and a connection is established (5570).

[0054] As mentioned above, according to the example 1 of an operation gestalt of above-mentioned this invention, according to the load of QOS which a client requires, and a server, a server can choose the network interface corresponding to conditions from two or more network interfaces, and can perform data communication.

[0055] Moreover, according to the above-mentioned example 1 of an operation gestalt, even if it knows no network address of the network interfaces of a server 3000 at the time of connection establishment, a client 3101 can establish a connection using the network interface according to QOS which a client requires, and can perform data communication. Since the switching table in the LAN switch 3050 can be updated according to the directions from a server 3000 according to the above-mentioned example 1 of an operation gestalt, the network address connected to the public network 3070 of a server 3000 can perform a client and data communication also for even free assigning the address of a network interface 3001 using a different path.

[0056] moreover, in the above-mentioned example 1 of an operation gestalt, although it is not alike too much, various selection procedures can be considered depending on the way of using the information on a QOS managed table which showed one of the procedures which choose a network interface.

[0057] (2) Explain the establishment method of the juxtaposition connection between the clients 3101 and servers 3000 which are the example 2 of an operation gestalt, next the example 2 of an operation gestalt of this invention using drawing 5 , drawing 1 , drawing 18 , drawing 19 , drawing 20 , and drawing 21 .

[0058] First, the flow of rough processing is shown using drawing 5 .

[0059] In drawing 5 , 3500, 3501, 3502, 3503, 3550, 3551, and 3552 show the condition of a TCP protocol, and 3590, 3591, 3592, 3593, and 3594 show 3 way handshake which establishes a connection between a client 3101 and a server 3000.

[0060] If the listen() call in the program shown in drawing 11 is performed (9007), the server 3000 of the CLOSED condition 3500 will be in a LISTEN condition, and will wait for the connection open request from a client (3501). The client 3101 of the CLOSED condition 3550 will create control-block TCB (Transmission Control Block) required in order to control data communication with the network address net1.1 which is one of the network interfaces of a server 3000, if the connect() call in the program shown in drawing 16 is performed (9058) (3580). Next, in order to require connection establishment from net1.1, the TCP packet which set (3581) and an SYN flag is sent to a server 3000. At this time, a client 3101 sends a connection's QOS (quality of service) to a server 3000 as a parameter of a TCP packet with an SYN flag (3590). QOS consists of three items of a class of service, a peak bandwidth (Mbps), and an average bandwidth (Mbps), as shown in 9052 of drawing 16 . A client 3101 is SYN when a TCP packet with an SYN flag is sent. It will be in a SENT condition (3551).

[0061] The server 3000 of a LISTEN condition will look for the network interface which fills QOS of a client 3101, if a TCP packet with QOS (quality of service) is received. When QOS which a client 3101 requires cannot be filled only with one network interface, two or more network interfaces are chosen and it is made to fill with those total value QOS which a client 3101 requires. The example of an operation gestalt of the procedure which chooses two or more network interfaces is mentioned later. The case where three (a network address net 1.2, net 1.3, net1.4) of the network interfaces 3002, 3003, and 3004 in drawing 3 are chosen now is described (3520). A server 3000 creates three TCBs (Transmission Control Block) corresponding to a network address net 1.2, net 1.3, and net1.4 (3521). A server 3000 is SYN about delivery (3591) and these TCBs to a client 3101 in the TCP packet to which the ACK flag to SYN from a client was attached to the client 3101 after creating three TCBs, and the TCP packet to which the SYN flag was attached. It changes into a RECVD condition (3502). The number 3 of a network address, a network address net 1.2, net 1.3, net1.4, and QOS (average

The number 3 of a network address, a network address net 1.2, net 1.3, net1.4, and QOS (average bandwidth) assigned to each path are attached to an SYN flag as a parameter. If the TCP packet with an SYN flag which the parameter accompanied is received, a client 3101 will delete TCB created to net1.1 (3582), and will create three TCBs corresponding to net 1.2, net 1.3, and net1.4 (3583). Next, a client 3101 will be in delivery (3592, 3593, 3594) and an ESTABLISHED condition about a TCP packet with an ACK flag to net 1.2, net 1.3, and net1.4, respectively (3552). If a server 3000 also receives three ACK, it will be in an ESTABLISHED condition (3503) and three connections will be established. Henceforth, between a client and a server, parallel communication by SEND/RECEIVE can be performed using three connections (3595).

[0062] The example of an operation gestalt of the method of the division and integration for parallel communication is explained using drawing 17 . Drawing 17 shows the case where data is sent to a client 3101 from a server 3000. The channel (it is equivalent to the channels 3012, 3013, and 3014 in drawing 3) by which the buffer in a server 3000, and 6130, 6131, 6132 and 6133 are connected to the buffer in a client 3101, and 6012, 6013, and 6014 are connected to a network 6070 for 6030, 6031, 6032, and 6033 from a server 3000, and 6110 show the channel (it is equivalent to the channel 3110 in drawing 3) connected to a network 6070 from a client 3101. If data is now SEND(ed) from application, the data will be held temporarily at the buffer 6030 of a TCP protocol layer. the data in 6030 was divided into three for every segment length specified by application, and it was proportional to the bandwidth assigned to buffers 6031, 6032, and 6033 at three channels -- it distributes the number every. For example, when the ratio of a bandwidth is 2:1:1, it distributes in order of 6031, 6031, 6032, and 6033, and, as for each buffer, data is held temporarily. In a TCP layer, the buffers 6031, 6032, and 6033 of a server 3000 and the buffers 6131, 6132, and 6133 of a client 3101 are made to correspond by 1 to 1, and data is sent to a client 3101 from a server 3000 mutually-independent as a connection whom each became independent of (it SEND(s)). That is, the data of buffers 6031, 6032, and 6033 is sent to a channel 6110 from channels 6012, 6013, and 6014, respectively. The data sent to the buffers 6131, 6132, and 6133 in a client 3101 is unified to one data, and the application on delivery and a client 3101 receives data to a buffer 6130. As mentioned above, between a TCP layer and the application layer, since division and integration of data are performed, parallel communication can be concealed to an application program. Therefore, parallel communication can be realized using the same program as a single communication link, and QOS which a client requires can be filled.

[0063] Moreover, the algorithm of division and integration may be as follows. When dividing the data in a buffer 6030 for every segment length, a serial number is added to each segment. Since the loaded condition of three channels changes dynamically, when distributing a segment to buffers 6031, 6032, and 6033 from a buffer 6030 The non-sent number of segments chooses the minimum buffer in buffers 6031, 6032, and 6033, and if the non-sent number of segments is equal Since addition can be added to the channel to which SEND processing is advancing most when the serial number of a top segment chooses the biggest buffer, a load is distributed dynamically and a more nearly high-speed communication link is attained.

[0064] The details of the example 2 of an operation gestalt of this invention shown using drawing 5 above are explained using drawing 1 , drawing 18 , drawing 19 , drawing 20 , and drawing 21 . Flow chart drawing of processing of the server 3000 after the condition that drawing 18 , drawing 19 , and drawing 20 are waiting for the connection establishment demand from a client in the state of LISTEN (3501), and drawing 21 show flow chart drawing of processing of a client 3101. In addition, drawing 18 omits explanation for the same flow chart drawing as drawing 9 .

[0065] In drawing 19 , the pointer to the QOS managed table entry recorded by 4050 of drawing 18 is followed, the record in a QOS managed table entry is investigated, and the network interface of a server 3000 which fulfills the following two conditions is chosen.

[0066] 1) They are two conditions of thing (4070) ** in the bandwidth of a non-reserved virtual channel (93) with the peak bandwidth smaller than the greatest thing which the average bandwidth

channel (93) with the peak bandwidth smaller than the greatest thing which the average bandwidth which a client's 3101 requires being smaller than the value which lengthened the sum total (95) of the maximum bandwidth (90) to a reserved bandwidth, and two clients 3101 require.

[0067] When there is no corresponding network interface, two or more network interfaces are chosen and it is made for the total value of each interface to fill QOS which a client 3101 requires. That is, the pointer to the QOS managed table entry recorded by 4050 is followed, the record in a QOS managed table entry is investigated, and the network interface of a server 3000 which fulfills the following two conditions is chosen.

[0068] 1) The average bandwidth which a client 3101 requires from the sum total of the maximum bandwidth (90) of two or more selected network interfaces Are smaller than the value which lengthened the sum total of the sum total (95) of the reserved bandwidth of two or more selected network interfaces, 2) A bandwidth chooses the one greatest virtual channel at a time in the virtual channel (93) which is not reserved [of two or more selected network interfaces]. They are two conditions of thing (4100) ** with the peak bandwidth smaller than those sum totals which a client 3101 requires.

[0069] Even if it uses two or more network interfaces, when the demand of a client 3101 cannot be filled, the amount of peak transfers for 1 minute (96) chooses the minimum network interface recently, without using two or more network interfaces (4110). Although shown neither in drawing 19 nor drawing 5 , when the demand of a client 3101 cannot be filled A server 3100 receives the client 3101 of a SYNSENT condition. Tell the purport with which the demand of a client 3101 cannot be filled as a parameter of a TCP packet with an ACK flag, have deliberations of a client 3101 and QOS, and a client 3101 respecifies QOS. again -- a TCP packet with an SYN flag -- a server 3000 -- delivery (3590) and new QOS -- being based -- a server 3000 -- a network interface -- searching (3520) -- you may have deliberations between the servers 3000 and clients 3101 to say.

[0070] It returns to drawing 19 again, and in 4070, when there is a corresponding network interface, a reserved bandwidth chooses the minimum interface from the network interfaces which fulfill conditions (4085). As mentioned above, the value for each network interface charge of an average bandwidth which the client 3101 divided and assigned to each network interface is demanding is applied to the reserved bandwidth (95) of the QOS managed table entry of all the network interfaces chosen by 4085, 4100, or 4110 (4120). Below, a routing table entry including the address of the selected network interface is used.

[0071] It moves to drawing 20 . It asks for the network address (71) of all network interfaces from the selected routing table entry (4500). Next, TCB (Transmission control Block) required to perform data communication of End-to-End using a TCP protocol is created corresponding to all the selected network interfaces (4510). Every one network address for which it asked by 4500 is specified as the transmitting agency address described in each TCB, and the network address net11.10 of a client 3101 is specified as a destination address. When TCB is created, they are delivery (4520) and SYN about the TCP packet with an SYN flag which added as a parameter the number of the network interface chosen as the client 3101 with the TCP packet with an ACK flag, all network addresses, and the average bandwidth assigned to each network interface. It will be in a RECVD condition (3502). As for a server 3000, a TCP packet with an ACK flag and a TCP packet with an SYN flag are sent to a client 3101 using the network interface as having received a client 3101 to the TCP packet with an SYN flag with the same server 3000. SYN In a RECVD condition, in the network interface corresponding to all the network addresses attached to the TCP packet with an SYN flag of clients 3101-4520, if a TCP packet with an ACK flag is received (4530), all the network interface addresses and network addresses of a client 3101 concerned are registered into the managed table of a connection establishment finishing channel (4540), and it will be in an ESTABLISHED condition (3503). Henceforth, the parallel data communication link according to QOS is performed between a client and a server.

[0072] The detailed procedure of a client 3101 is shown using drawing 21 . SYN It omits for the same

flow chart drawing as drawing 12 until it will be in the SENT condition 3551.
[0073] SYN The client 3101 of a SENT condition waits for the TCP packet with an ACK flag sent from a server 3000 (3551). If ACK and a TCP packet with an SYN flag are received, the number of the selected network interface which is the parameter of SYN will be investigated (4600). A TCP packet with an ACK flag is sent to zero case by addressing to net1.A to a server 3000 (4640). In one case, the network address specified with the parameter investigates whether it is equal to net1.A (4610). In being equal, it sends a TCP packet with an ACK flag to a server 3000 by addressing to net1.A (4640). The case of an inequality, or when the value of the parameter of SYN is two or more pieces in 4600, it is regarded as that by which the server 3000 changed the network interface, and TCB for the communication link with net1.A created by 4310 is deleted, and TCB corresponding to each network address is created so that it can communicate with all the network interfaces newly specified with the parameter of SYN (4620). In the case of the network in which band reservation like ATM is possible, according to three QOS(s) (average bandwidth) told from the server, a client 3101 chooses three virtual channels and aims at establishment of three connections. next, a TCP packet with an ACK flag is sent to addressing to each of the network address specified with the parameter of SYN (4630). In the case of a network like ATM, a TCP packet with an ACK flag is sent from each of three virtual channels. If ACK is returned next, all the network addresses of the server 3000 specified as the connection establishment finishing channel managed table in a client with the parameter of SYN and the network address net11.10 of a client 3101 are registered (4650), and it will be in an ESTABLISHED condition (3552). Henceforth, the parallel data communication link according to QOS is performed between a client and a server.
[0074] The connection establishment finishing channel managed table of the server 3100 at this time and a client 3101 is shown in drawing 13 and drawing 14 , respectively. In drawing 13 , 3820 shows a connection establishment finishing channel managed table, and it is shown that three connections are established by each entry of 3821, 3822, and 3823. Similarly, in drawing 14 , 3910 shows a connection establishment finishing channel managed table, and it is shown that three connections are established by each entry of 3911, 3912, and 3913. Thus, a channel [finishing / establishment of End-to-End] is managed.
[0075] Next, actuation of the LAN switch 3050 in the juxtaposition connection establishment method is explained using drawing 22 and drawing 23 . Except for an address switching table, since it is the same as drawing 7 , a description of drawing omits drawing 22 . In drawing 22 , 5011 (a) shows an address switching table when a client 3101 sends out a TCP packet with an SYN flag to a server 3000, and 5011 (b) shows the address switching table after a client 3101 sends out a TCP packet with an ACK flag to a server 3000 and a connection is established.
[0076] Actuation of the LAN switch 3050 is explained using drawing 23 . The case (5700) where routing of the TCP packet with an SYN flag addressed to net1.1 of a server 3000 was carried out, and it reaches port #0 of the LAN switch 3050 and VC=11 (3074a) from a client 3101 is explained. The LAN switch 3050 investigates a translation table 5000, and asks for sending-out place port # of the TCP packet with an SYN flag addressed to net1.1 being 1 (5710). Next, VC=1 (3011a) is chosen from the virtual channels of port #1, and it registers with the address switching table 5011 (a) so that (port #0, VC=11), and (port #1, VC=1) may be switched mutually (5720). Now, a server 3000 searches the QOS managed table entries 5110, 5120, 5130, and 5140 to the connection establishment demand of a client 3101, and the case where three of channels 3012, 3013, and 3014 (a network address net 1.2 and net1.3 net1.4) are chosen as a network interface is described. First, a server 3000 reserves three virtual channels, (port #3, VC=1), and (port #4, VC=1), to the LAN switch 3050 (port #2, VC=1), in order to enable it to use three channels (5730). Next, a server 3000 returns a TCP packet with an ACK flag, and the TCP packet with an SYN flag to which the parameter was attached to a client 3101 via (port #1, VC=1) to (port #0, VC=11) of the LAN switch 3050. The average bandwidth which can use the network address of the selected network interface and each network interface is added to an SYN flag

network address of the selected network interface and each network interface is added to an SYN flag as QOS (5740). Then, it requires that the entry which specifies switching with (port #1, VC=1), and (port #0, VC=11) should be deleted to the LAN switch 3050, and it releases so that the others can use this path (5750).

[0077] If a client 3101 receives a TCP packet with an SYN flag and the network address of the selected network interface and the average bandwidth for which each network interface can use it are got to know, it will return ACK to each network interface. The virtual channel of a path until it results in the LAN switch 3050 from a client 3101 is newly secured so that the conditions of an average bandwidth may be filled with the process in which ACK is returned. Now, suppose that it reached in three paths, (port #0, VC=12), (port #0, VC=13), and (port #0, VC=14), to the LAN switch 3050 (5760). The LAN switch 3050 obtains port number #2 which reach to a network interface, #3, and #4 from the destination net 1.2, net 1.3, net1.4, and the port number translation table 5000 of three TCP packets with an ACK flag. The LAN switch 3050 registers the entry of an address switching table with (port #3, VC=1) which are reserved by 5730 (port #2, VC=1), and (port #4, VC=1), respectively (port #0, VC=12) so that (port #0, VC=13), and (port #0, VC=14) may be switched (5770). Consequently, an address switching table is updated as shown in 5011 (b) (5780), three connections are established (5790), and data communication by SEND/RECEIVE of juxtaposition is performed.

[0078] As mentioned above, according to the example 2 of an operation gestalt of above-mentioned this invention, according to the load of QOS which a client requires, and a server, a server chooses two or more network interfaces corresponding to conditions from two or more network interfaces, and can perform a parallel data communication link.

[0079] Moreover, according to the above-mentioned example 2 of an operation gestalt, even if it knows no network address of the network interfaces of a server 3000 at the time of connection establishment, a client 3101 can establish a connection using the network interface according to QOS which a client requires, and can perform a parallel data communication link.

[0080] moreover, in the above-mentioned example 2 of an operation gestalt, although it is not alike too much, various selection procedures can be considered depending on the way of using the information on a QOS managed table which showed one of the procedures which choose a network interface.

[0081] (3) Although the network address of a proper was assigned to the network interfaces 3001, 3002, 3003, and 3004 of a server 3000, respectively, according to the example of an operation gestalt shown in drawing 6 and drawing 24 , in the example 2 of an operation gestalt of the example of operation gestalt 3 above, parallel communication can be performed only by assigning a single network address to a server 3000 using network interfaces 3001, 3002, 3003, and 3004.

[0082] In drawing 24 , a server and 3050 express a LAN switch, 3011, 3012, 3013, 3014, and 3074 express the channel of port #1, #2, #3, #4, and #0, respectively, and 3000 corresponds with the same number of drawing 3 . 7000 -- a parallel communication flag detector and 7010 -- in a packet switching circuit and 7100, a destination network address and 7130 show a parallel communication flag, and, as for the header of a packet, and 7110, 7135 shows the port number of a server 3000, as for a transmitting agency network address and 7120. The parallel communication flag 7130 and a port number 7135 are the items added to the option field of a packet. The network address net1.1 is assigned only to port #1 in port #1 thru/or 4.

[0083] In drawing 6 , 3500, 3501, 3502, 3503, 3550, 3551, and 3552 show the condition of a TCP protocol, and 3690, 3691, 3692, 3693, and 3694 show 3 way handshake which establishes a connection between a client 3101 and a server 3000. The flow of processing of the 2nd juxtaposition connection establishment method is shown using drawing 6 . until a server 3000 will be in a LISTEN condition (3501) -- a client 3101 -- SYN Since it is the same as drawing 5 , explanation is omitted until it will be in a SENT condition (3561).

[0084] The server 3000 of a LISTEN condition (3501) will look for the network interface which fills QOS of a client 3101, if a TCP packet with QOS (quality of service) is received from a client 3101

QOS of a client 3101, if a TCP packet with QOS (quality of service) is received from a client 3101 (3690). When QOS which a client 3101 requires cannot be filled only with one network interface, two or more network interfaces are chosen and it is made to fill with those total value QOS which a client 3101 requires. The case where three (port numbers 2, 3, and 4) of the network interfaces 3002, 3003, and 3004 in drawing 3 are chosen now is described (3620). A server 3000 creates three TCBs (Transmission Control Block) corresponding to port numbers 2, 3, and 4 (3621). A server 3000 is SYN about delivery (3691) and this TCB to a client 3101 in the TCP packet to which the ACK flag to SYN from a client was attached to the client 3101 after creating three TCBs, and the TCP packet to which the SYN flag was attached. It changes into a RECVD condition (3502). The number 3 of a port number and port numbers 2, 3, and 4 are attached to an SYN flag as a parameter. If the TCP packet with an SYN flag which the parameter accompanied is received, a client 3101 will delete TCB created to net1.1 (3682), and will create net1.1 and a port number 2, net1.1 and a port number 3, net1.1, and three TCBs corresponding to a port number 4 (3683). Next, a client 3101 will be in delivery (3692, 3693, 3694) and an ESTABLISHED condition about a TCP packet with an ACK flag to net1.1 and a port number 2, net1.1 and a port number 3, net1.1, and a port number 4, respectively (3552). If a server 3000 also receives three ACK, it will be in an ESTABLISHED condition (3503) and three connections will be established. Henceforth, between a client and a server, parallel communication by SEND/RECEIVE can be performed using three connections (3695).

[0085] The header format of the packet which can express "net1.1 and a port number 2" to drawing 24 is shown. In drawing 24 , in communicating by using two or more ports for juxtaposition, the parallel communication flag 7130 in the option field of the header of a packet is set to "1", and, similarly it sets "2" as the port number 7135 in option field. The parallel communication flag detector in the LAN switch 3050 will send a packet to a server 3000 using the network interface of the port number detected and specified [port number / in the header of delivery and a packet] in this packet to the packet switching circuit 7010, if it detects that the parallel communication flag in the header of a packet is 1. As mentioned above, about the packet sent out from a client 3101 to a server 3000, parallel communication can be performed using network interfaces 3001, 3002, 3003, and 3004.

[0086] On the other hand, about the packet sent out from a server 3000 to a client 3101, by setting up the network address of the network interface in the routing table entry shown by drawing 1 as a port number, a single network address is only assigned to a server 3000, and parallel communication can be performed using network interfaces 3001, 3002, 3003, and 3004.

[0087] As mentioned above, a client 3101 and a server 3000 can perform parallel communication only by assigning a single network address to a server 3000 by extending the header format of a packet using network interfaces 3001, 3002, 3003, and 3004.

[0088] In the above (1) thru/or the example of an operation gestalt of (3), a server can choose now the network interface which fills the QOS demand of a client by describing the connection establishment method between the client in a TCP/IP protocol layer, and a server, and adding the column (71) of the network address of a network interface to routing table.

[0089] However, it not only fills the QOS demand of a client, but according to the example of an operation gestalt shown in drawing 25 and drawing 26 , by using the connection management table shown in drawing 25 , it can choose a network interface so that a server may distribute the load of the communications processing between its network interfaces. Furthermore, although it asks for the gateway address which is the following packet sending-out place using routing table as usual, the network interface which sends out a packet can choose the network interface with which the client required connection of the server by using the registration table in which the network interface address connected to the connection management table shown in drawing 25 and the LAN switch was described. Consequently, the two-way communication using the network interface with which the client required connection of the server becomes possible.

[0090] Drawing 25 shows the connection management table on the server 3000 of drawing 3 . In

drawing 25 , 8050, 8051, and 8052 show each entry of a connection management table, and hold the information about the connection whom the server 3000 has established between clients. The protocol name which is using 8001 by the communication link in the connection management table entry 8050, The network address of the network interface of a server with which, as for 8002, the client required connection from the server, A port number for a server to identify a connection, as for 8003 and 8004 The network address of a client, The condition of a connection like CLOSED, LISTEN, and ESTABLISHED as showed 8005 to the port number of a client side and showed 8006 to drawing 4 is shown, and 8006 shows the pointer to the following connection management table entry. The entry of a connection management table is generated at the time of connection establishment. 8040 shows the pointer to the entry of the head of a connection management table.

[0091] Corresponding to the connection identifier (file descriptor) 8010 when communicating between a client and a server thru/or 8012, there are the pointer 8015 to the entry concerned of a connection management table thru/or 8017. A pointer 8015 thru/or 8017 point out each entry 8050 of each connection management table thru/or 8052.

[0092] 8020 shows the registration table of the network interface address connected to the LAN switch. Each of network interface 3001 of the network interface address registered into an entry 8021 thru/or 8024 thru/or 3004 is connected to the LAN switch 3050 as shown in drawing 3 . So, even if it sends out a packet from which network interface of 8021 thru/or 8024, routing of the packet can be carried out to the same network. Therefore, if a network interface is chosen so that a network interface 3001 thru/or the load of 3004 may be distributed, a high total throughput can be obtained. Hereafter, the detailed example of an operation gestalt is described.

[0093] The flow chart of drawing 26 shows the example of 1 operation gestalt of the juxtaposition network connection method of this invention which realizes the communication link between a client 3101 and a server 3000 in the high order of a TCP/IP protocol layer.

[0094] A client 3101 sends a connection open request to a server 3000 (8111). A server 3000 receives waiting and the connection open request from a client 3101 for a connection open request (8101). A client 3101 sends a QOS parameter to a server 3000 (8113). At this time, in using two or more network interfaces as a QOS parameter, it specifies the number of network interfaces, or the peak bandwidth and average bandwidth to a connection are specified. It investigates whether routing is possible to a client 3101 from the LAN switch 3050 shown in drawing 3 when a server 3000 receives a QOS parameter from a client 3101, and if routing is possible, the entry of the connection management table shown in drawing 25 will be followed, and the number of connections of an ESTABLISHED condition will choose the minimum network interface (8103). From the LAN switch 3050 to a client 3101, it can be judged that routing is possible whether routing is possible, if the gateway address which made it the key, searched and was obtained is connected [network address / of a client 3101] with the network address of the LAN switch 3050 in the routing table 100 of the former shown in drawing 2 thru/or 150.

[0095] The selection procedure of a network interface is explained to details from the LAN switch 3050 about the case where routing is possible, using drawing 25 to a client 3101. The connection management table entry 8050 is accessed from the pointer 8040 to the head entry of a connection management table. A local address 8002 counts the number of connections whose condition 8006 of a connection is ESTABLISHED for every equal network interface. A local address 8002 is equal to either of the network interface addresses of a server 3000. Then, the number of entries searches for the minimum network interface out of the network interface registered into the registration table 8020 of the network interface address connected to the LAN switch. Moreover, each entry may be followed like the example of an operation gestalt (1) using the pointer 84 to degree entry in the network interface information table shown in drawing 1 , and a load may choose the minimum network interface according to the statistical information of 90 thru/or 97 currently described at the QOS

managed table entry shown with the pointer to a QOS managed table entry. For example, 94 virtual channels may choose the minimum network interface, or the amount 97 of average transfers for 1 minute may choose the minimum network interface recently.
[0096] Moreover, when the number of bigger network interfaces than 1 is describing as a QOS parameter, only the number specified one by one is chosen from an entry with few connections.
[0097] It returns to the flow chart of drawing 26 . A server 3000 sends the network address of the selected network interface, and the port number for a communication link to a client 3101 (8105). socket for a communication link will be generated (8117) and a client 3101 will send a connection's open request to the network interface of the server 3000 which received, if a network address and a port number are received (8115) (8119). A client can distribute the load of each network interface of a server by reestablishing the network interface and connection specified by a server 3000. A server 3000 fork(s) a child process, in order to receive the connection re-open request from a client 3101 (8107) and to plan ** and the load distribution of communications processing. When a network interface exists in each node like especially a parallel computer, a child process is fork(ed) to each node corresponding to the selected network interface (8108). Then, data is transmitted and received between a client and a server (8109 8121). When a server transmits data to a client, using the connection identifier 8010 of the server corresponding to the connection concerned, it asks for the connection management table entry 8050 from the pointer 8015 to a connection management table entry, and a packet is sent out from the network interface shown by the local address 8002 in the entry (8109). Consequently, the two-way communication using the network interface with which the client required connection of the server becomes possible.
[0098] As mentioned above, a client can perform two-way communication using the network interface which required connection to a server, without changing the conventional routing table by adding the registration table of the network interface address connected to the LAN switch, and using the local address of a connection management table further. Moreover, by counting the number of entries of a connection management table, by judging the load of each network interface and choosing the network interface which a server serves as a subject and is used by the communication link with a client, the load distribution of communications processing can be planned now and the system throughput of networking processing can be improved.
[0099]
[Effect of the Invention] As mentioned above, in the server equipped with two or more network interfaces, using the network interface according to QOS which a client requires, it can communicate or, according to this invention, a high speed and efficient parallel communication can be performed using two or more network interfaces.

[redacted]

[Translation done.]

[redacted]

DESCRIPTION OF DRAWINGS

[redacted]

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the example of a gestalt of operation of the entry of the routing table concerning this invention, and the entry, the entry of a network interface information table and a QOS (quality of service) managed table.

[Drawing 2] It is drawing showing the conventional routing table, and the entry and the entry of a network interface information table.

[Drawing 3] It is the whole network connection system block diagram of this invention.

[Drawing 4] It is drawing showing the example of a gestalt of implementation of the connection establishment method of this invention.

[Drawing 5] It is drawing showing the example of a gestalt of operation of the juxtaposition connection establishment method of this invention.

[Drawing 6] It is drawing showing the example of a gestalt of operation of the 2nd juxtaposition connection establishment method of this invention.

[Drawing 7] It is a block diagram explaining the example of a gestalt of implementation of actuation of the LAN switch in the connection establishment method of this invention.

[Drawing 8] It is flow chart drawing explaining the example of a gestalt of implementation of actuation of the LAN switch in the connection establishment method of this invention.

[Drawing 9] It is flow chart drawing explaining the example of a gestalt of implementation of actuation of the server in the connection establishment method of this invention.

[Drawing 10] It is flow chart drawing explaining the example of a gestalt of implementation of actuation of the server in the connection establishment method of this invention.

[Drawing 11] It is flow chart drawing explaining the example of a gestalt of implementation of actuation of the server in the connection establishment method of this invention.

[Drawing 12] It is flow chart drawing explaining the example of a gestalt of implementation of actuation of the client in the connection establishment method of this invention.

[Drawing 13] It is drawing explaining the example of a gestalt of operation of the routing table of the server in the network connection method of this invention.

[Drawing 14] It is drawing explaining the routing table of the client in the network connection method of this invention.

[Drawing 15] It is drawing showing the network connection in the conventional server.

[Drawing 16] It is drawing showing the example of a gestalt of implementation of the program of a client and a server in an application program.

[Drawing 17] It is drawing showing the example of a gestalt of operation of the division / integrated method of the data for parallel communication.

[Drawing 18] It is flow chart drawing explaining the example of a gestalt of implementation of actuation of the server in the juxtaposition connection establishment method of this invention.

[Drawing 19] It is flow chart drawing explaining the example of a gestalt of implementation of actuation of the server in the juxtaposition connection establishment method of this invention.

[Drawing 20] It is flow chart drawing explaining the example of a gestalt of implementation of actuation of the server in the juxtaposition connection establishment method of this invention.

[Drawing 21] It is flow chart drawing explaining the example of a gestalt of implementation of actuation of the client in the juxtaposition connection establishment method of this invention.

[Drawing 22] It is a block diagram explaining the example of a gestalt of implementation of actuation of the LAN switch in the juxtaposition connection establishment method of this invention.

of the LAN switch in the juxtaposition connection establishment method of this invention.

[Drawing 23] It is flow chart drawing explaining the example of a gestalt of implementation of actuation of the LAN switch in the juxtaposition connection establishment method of this invention.

[Drawing 24] They are the block diagram of the LAN switch in the 2nd juxtaposition connection establishment method of this invention, and drawing showing the example of a gestalt of operation of the header format of a packet.

[Drawing 25] It is drawing explaining the routing method of the server in the juxtaposition connection establishment method of this invention.

[Drawing 26] It is drawing showing the example of a gestalt of operation of the 4th juxtaposition connection establishment method of this invention.

[Description of Notations]

The network address of a network interface, 74 : 71: The pointer to degree entry of the same destination address, 85: The pointer to a QOS managed table entry, 90 : The maximum bandwidth of the network interface concerned, 92: The bandwidth of each virtual channel, 95 : The sum total of the already reserved bandwidth, The amount of peak transfers for 1 minute, and recently [97:] recently 96 : The amount of average transfers for 1 minute, 3000 : A server, 3011 or a 3014:transfer way, a 3050:LAN switch, 3070: PBX, the 3101:clients 1 and 3102 : The gateway, 3570: An SYN (synchronization) packet with a QOS parameter, an SYN (synchronization) packet with a 3571:ACK packet + network address, 3572: An ACK packet, 3800 : The routing table of a server, 3900: The routing table of a client 1, 9001 or the example program of a 9015:server, 9050 or the example program of a 9061:client, 6030 or the buffer of a 6033:server, 6130, or the buffer of the 6133:client 1.

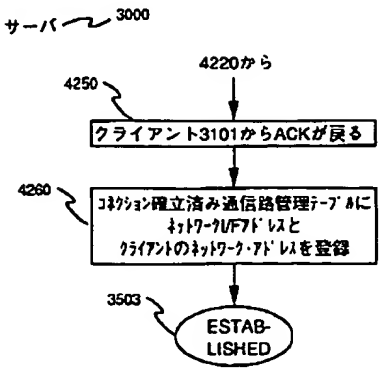
[redacted]

[Translation done.]

DRAWINGS

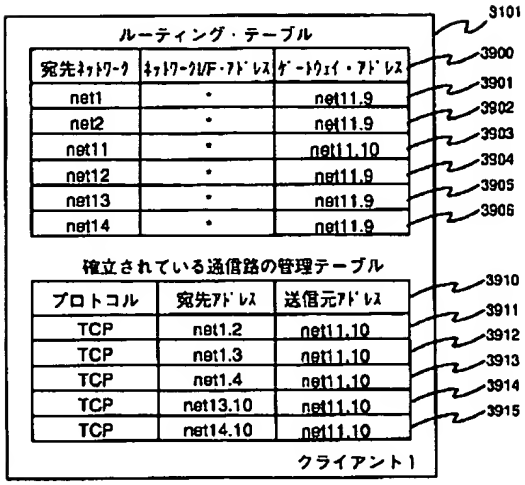
[Drawing 11]

図１１



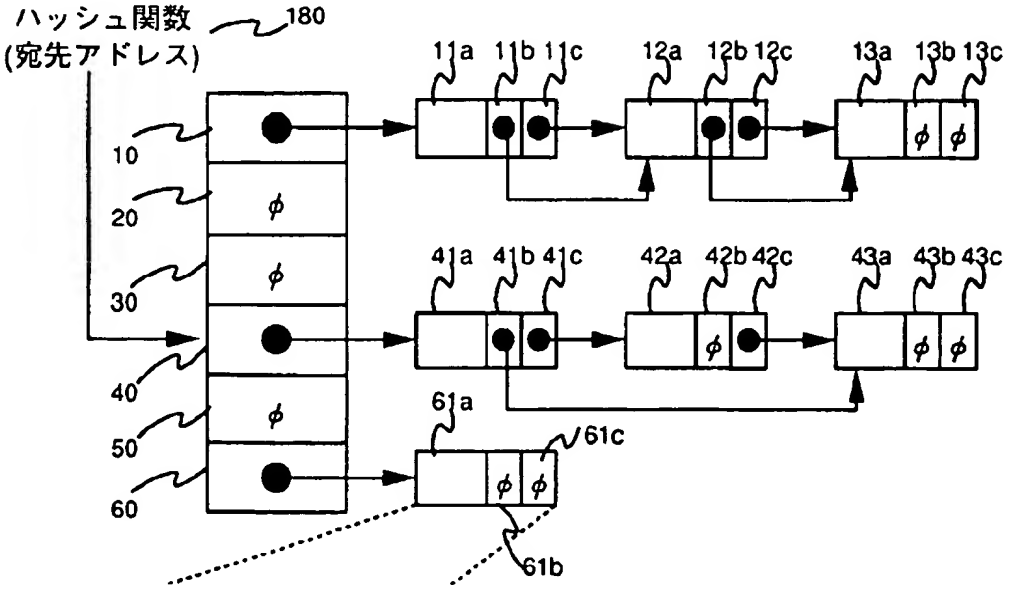
[Drawing 14]

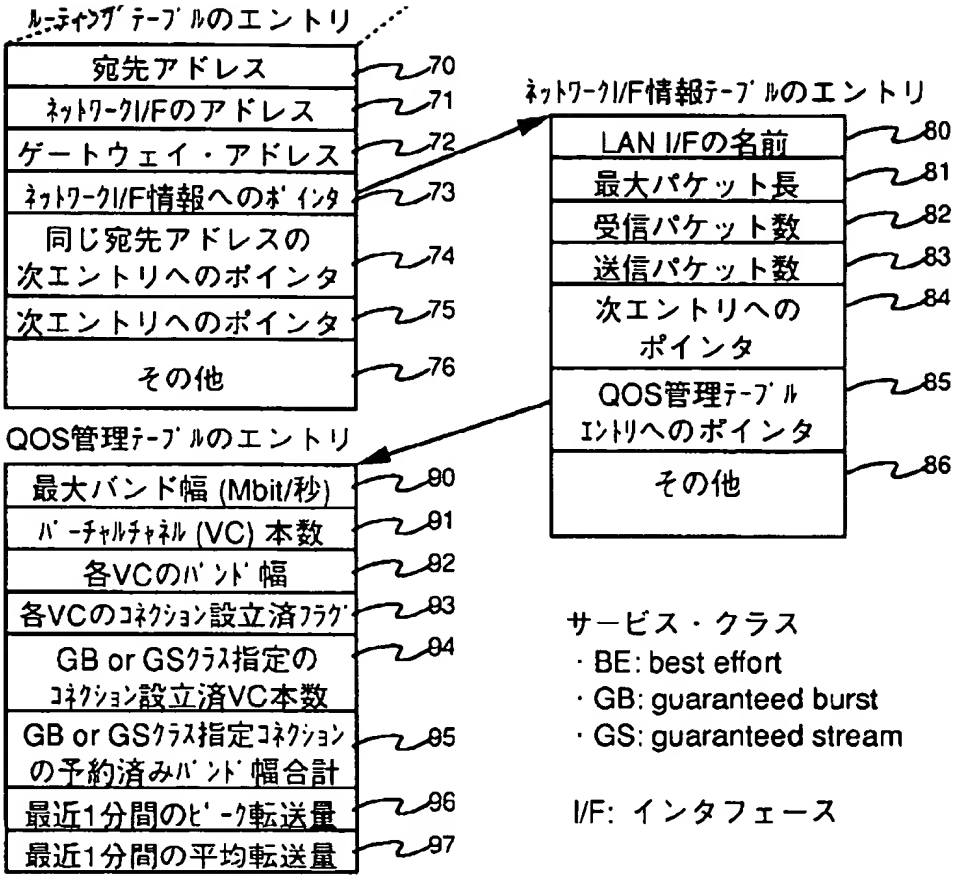
図１４



[Drawing 1]

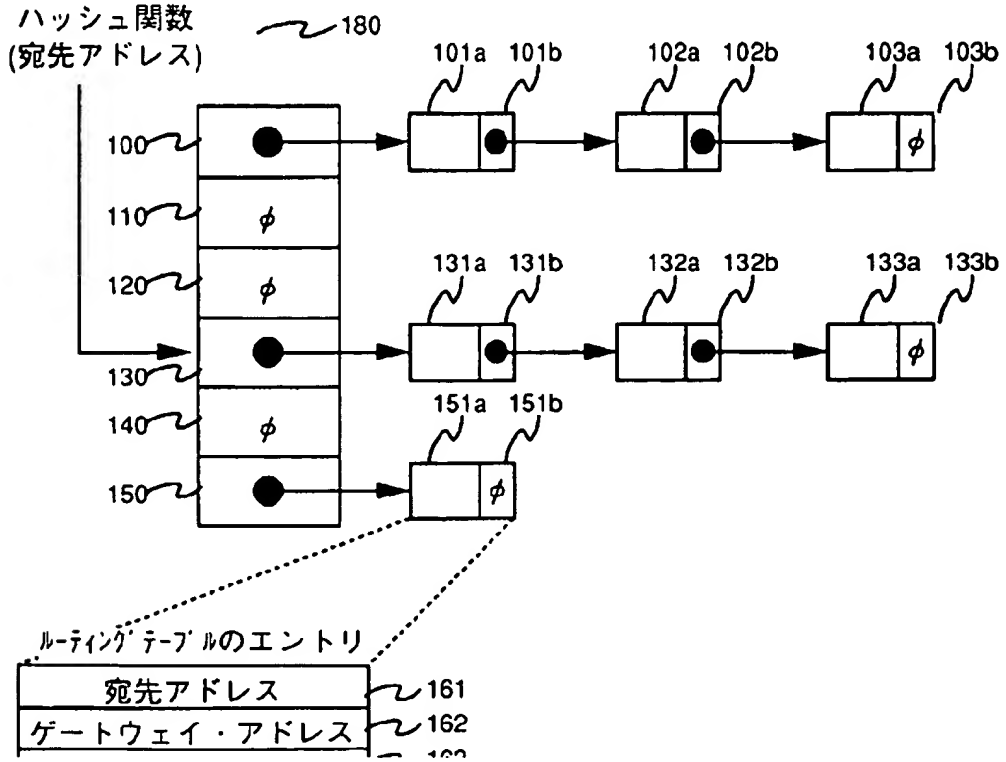
図１

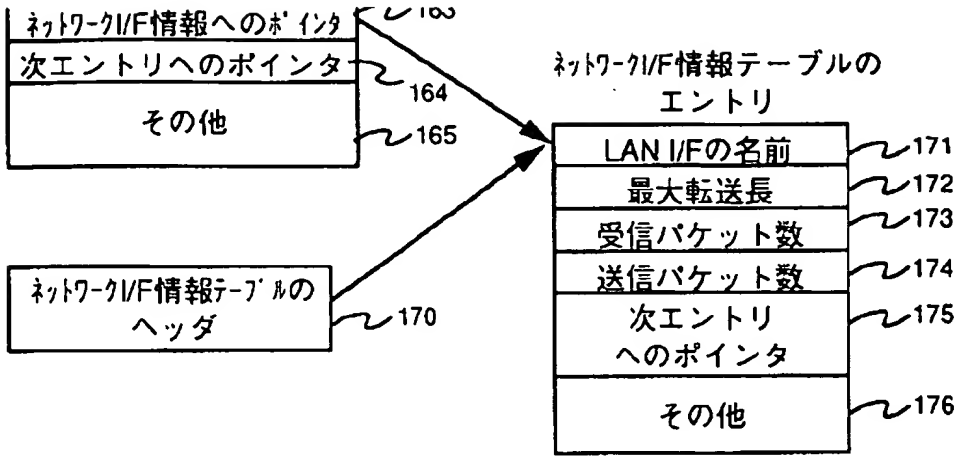



ﾙｰﾃｨﾝｸﾞﾃｰﾌﾞﾙのエントリ
宛先アドレス
ﾈｯﾄﾜｰｸI/Fのアドレス
ゲートウェイ・アドレス
ﾈｯﾄﾜｰｸI/F情報へのﾎﾟｲﾝﾀ
同じ宛先アドレスの次エントリへのポインタ
次エントリへのポインタ
その他
70
71
72
73
74
75
76
ﾈｯﾄﾜｰｸI/F情報ﾃｰﾌﾞﾙのエントリ
LAN I/Fの名前
最大パケット長
受信パケット数
送信パケット数
次エントリへのポインタ
QOS管理ﾃｰﾌﾞﾙエントリへのポインタ
その他
80
81
82
83
84
85
86
QOS管理ﾃｰﾌﾞﾙのエントリ
最大バンド幅 (Mbit/秒)
ﾊﾞｰﾁｬﾙﾁｬﾈﾙ (VC) 本数
各VCのﾊﾞﾝﾄﾞ幅
各VCのｺﾈｸｼｮﾝ設立済ﾌﾗｸﾞ
GB or GSｸﾗｽ指定のｺﾈｸｼｮﾝ設立済VC本数
GB or GSｸﾗｽ指定ｺﾈｸｼｮﾝの予約済みﾊﾞﾝﾄﾞ幅合計
最近1分間のﾋﾟｰｸ転送量
最近1分間の平均転送量
90
91
92
93
94
95
96
97
サービス・クラス
・BE: best effort
・GB: guaranteed burst
・GS: guaranteed stream
I/F: インタフェース

[Drawing 2]

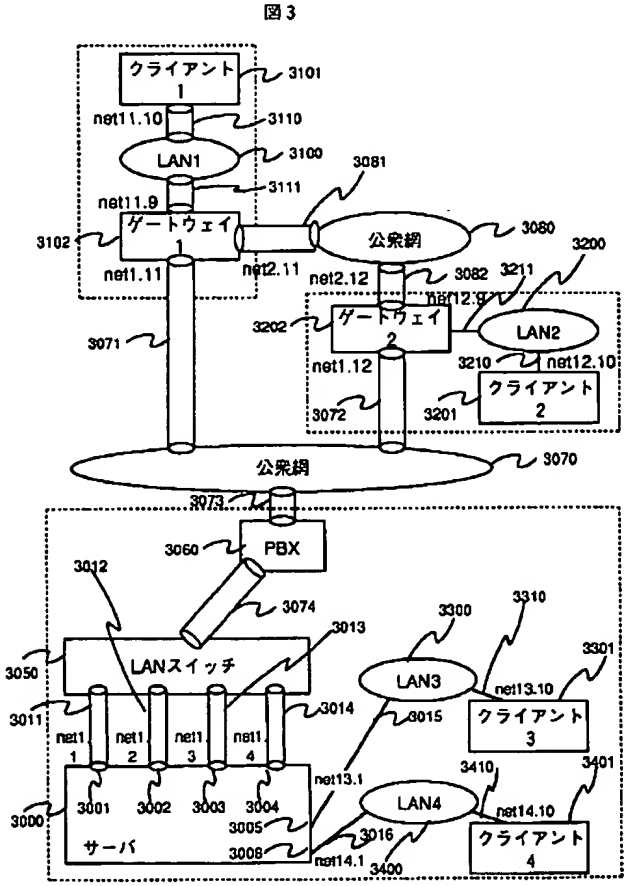
図 2


ハッシュ関数
(宛先アドレス)
180
100
110
120
130
140
150
101a 101b
102a 102b
103a 103b
131a 131b
132a 132b
133a 133b
151a 151b
ﾙｰﾃｨﾝｸﾞﾃｰﾌﾞﾙのエントリ
宛先アドレス
ゲートウェイ・アドレス
161
162



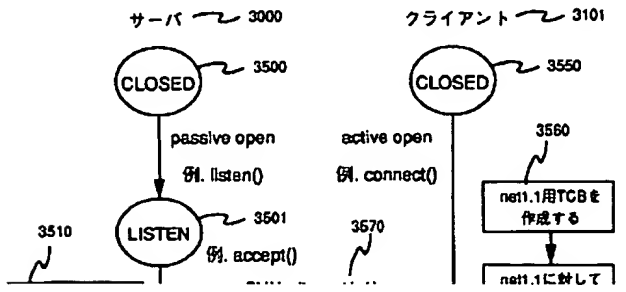
[Drawing 3]

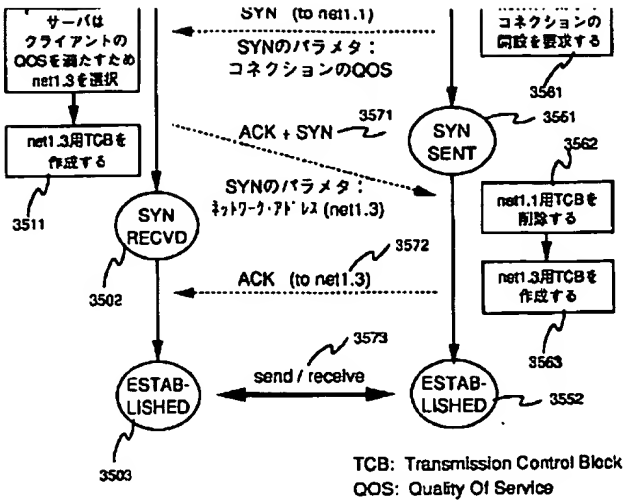
図3



[Drawing 4]

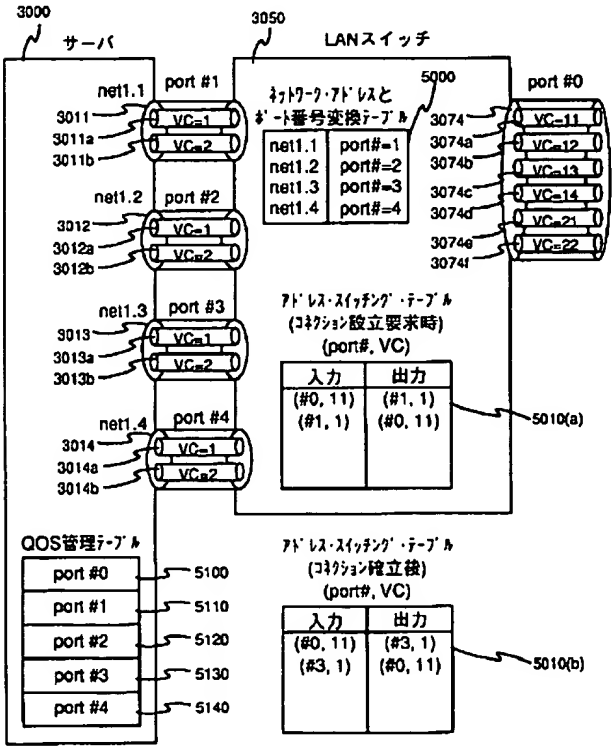
図4





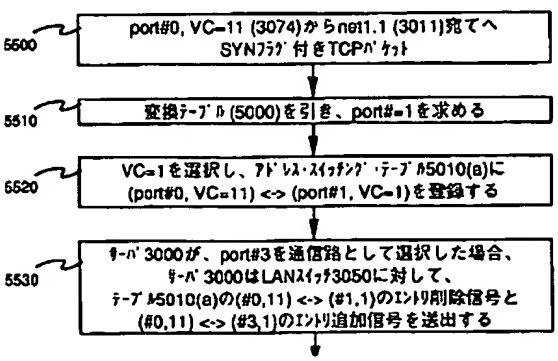
[Drawing 7]

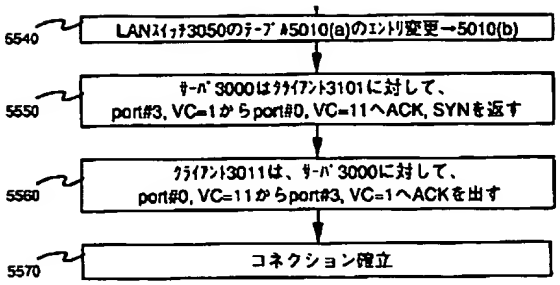
図7



[Drawing 8]

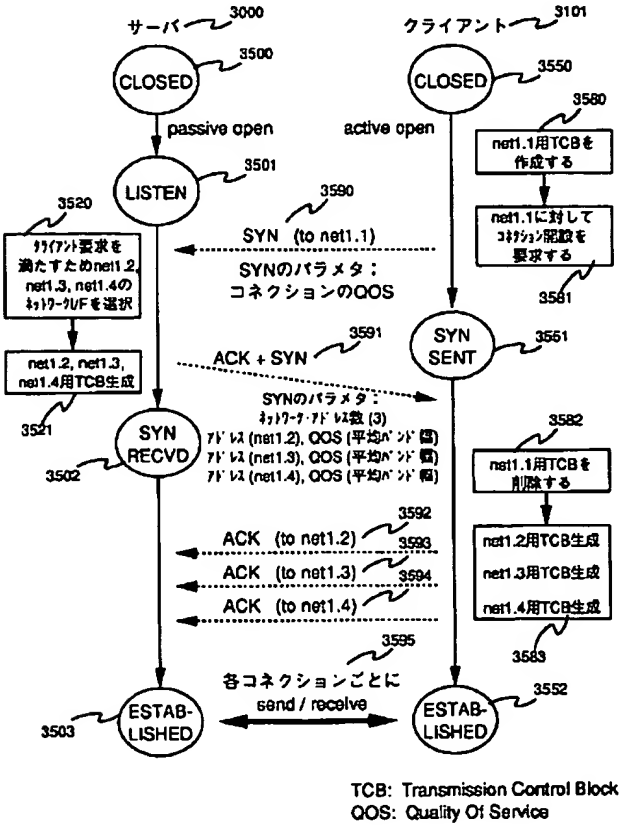
図8





[Drawing 5]

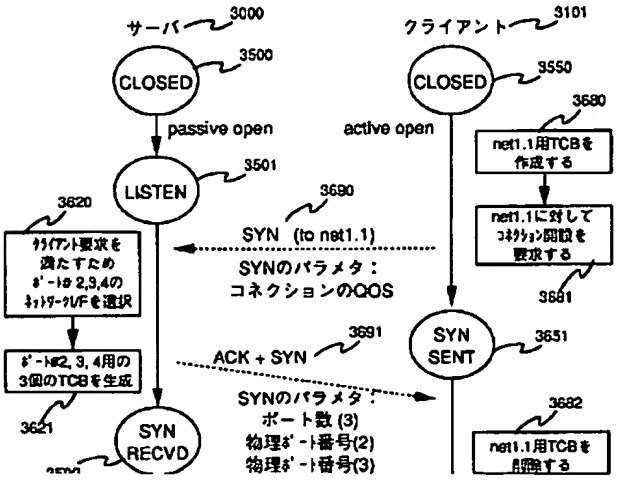
図5

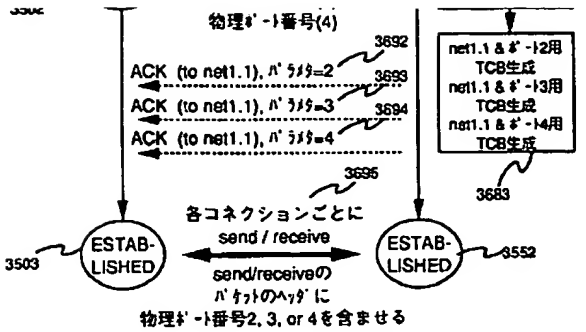


TCB: Transmission Control Block
QOS: Quality Of Service

[Drawing 6]

図6

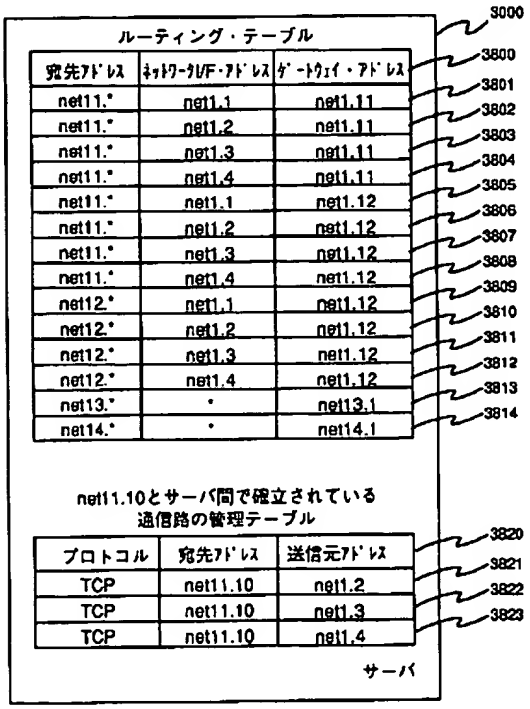




TCB: Transmission Control Block
QOS: Quality Of Service

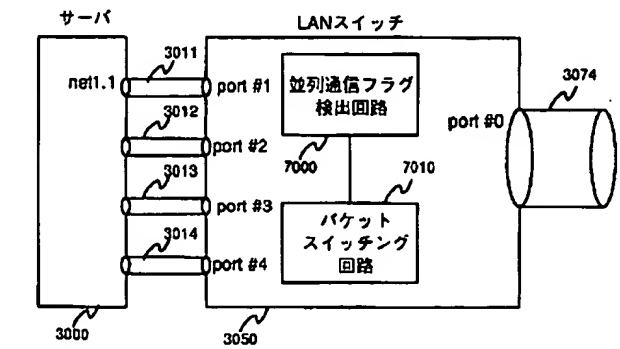
[Drawing 13]

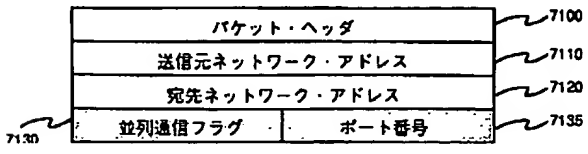
図１３

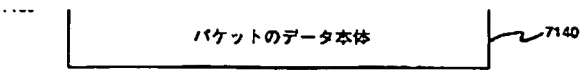


[Drawing 24]

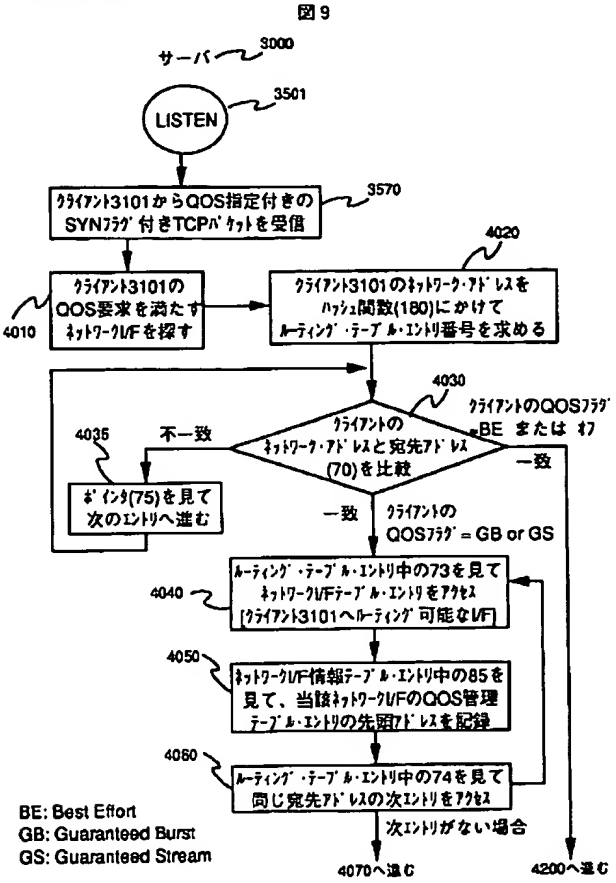
図２４



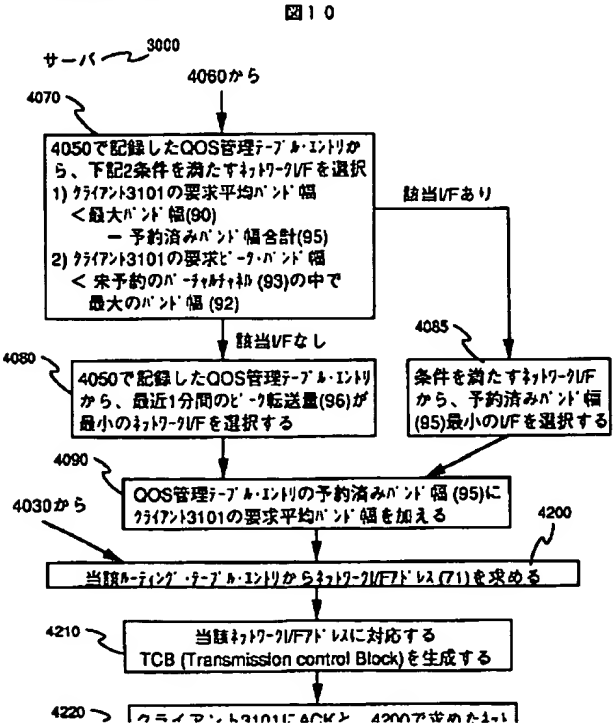


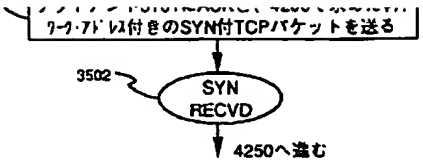


[Drawing 9]



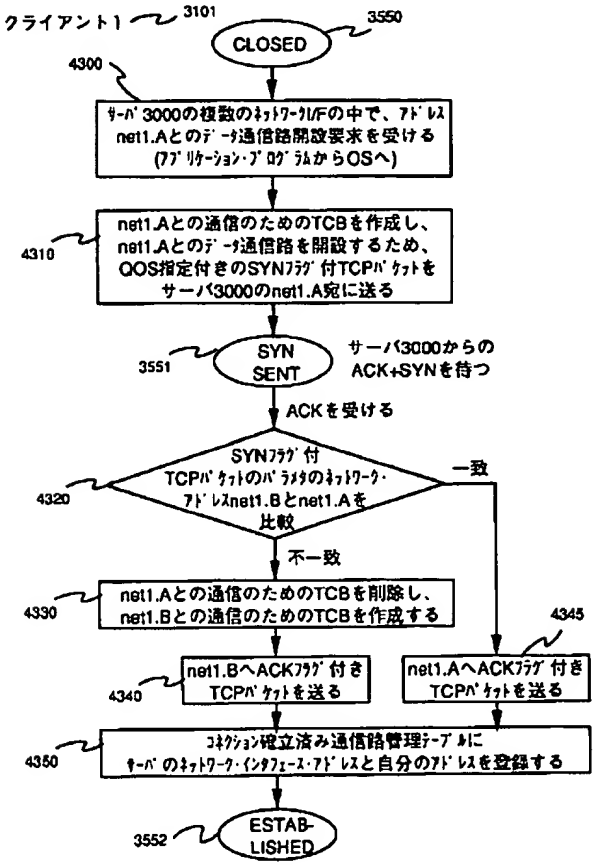
[Drawing 10]





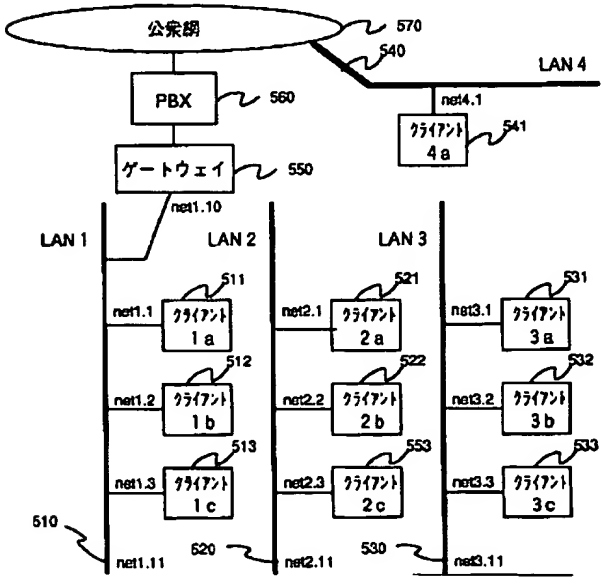
[Drawing 12]

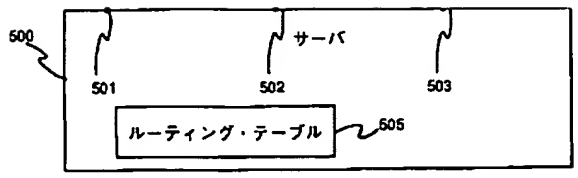
図１２



[Drawing 15]

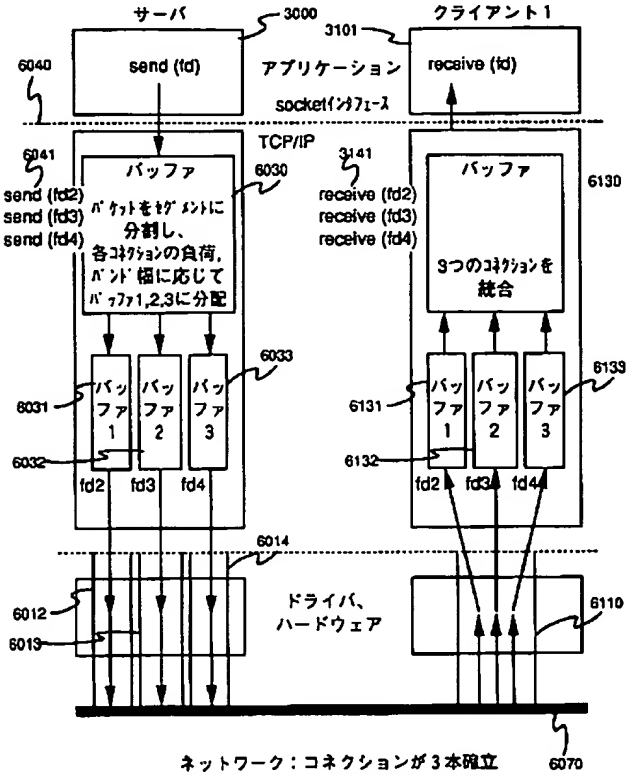
図１５





[Drawing 17]

図１７



[Drawing 16]

図１６

サーバ３０００のプログラム例

```
#define SERV_TCP_PORT  6001                                   9001

fd = socket(AF_INET, SOCK_STREAM, 0);                         9002

serv_addr.sin_family = AF_INET;                               9003
serv_addr.sin_addr.s_addr = htonl(INADDR_ANY);                9004
serv_addr.sin_port = htons(SERV_TCP_PORT);                    9005

bind(fd, (struct sockaddr *) &serv_addr,                      9006
     sizeof(serv_addr));

listen (fd, 5);                                               9007

for ( ; ; ) {                                                 9008
     newfd = accept(fd, (struct aockaddr *)
                    &cli_addr, &clilen);                      9009
     childpid = fork();                                       9010
     if (childpid == 0) {                                     9011
          close(fd);          /* child process */             9012
          send and receive data to and from CLIENT;           9013
          exit(0);                                            9014
     }
     close(newfd);            /* parent process */            9015
}
```

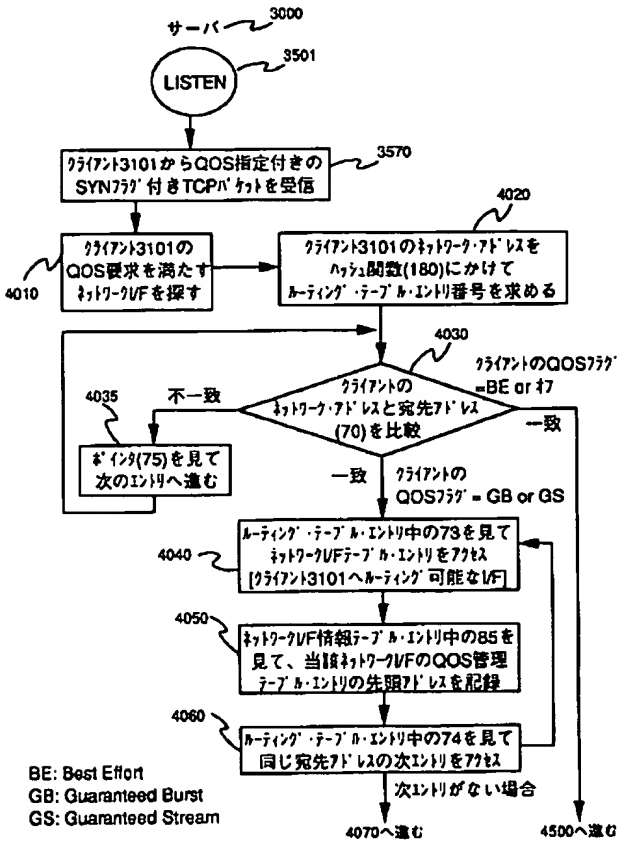
クライアント３１０１のプログラム例

```
#define SERV_TCP_PORT   6001                                  9050
#define SERV_HOST_ADDR  net1.1                                9051
#define QOS  {SERVICE_CLASS,                                  9052
              PEAK_BANDWIDTH,AVERAGE_BANDWIDTH}

fd = socket(AF_INET, SOCK_STREAM, 0);                         9053

                                                              9055
```

```
serv_addr.sin_family = AF_INET;
serv_addr.sin_addr.s_addr = htonl(SERV_HOST_ADDR);
serv_addr.sin_port = htons(SERV_TCP_PORT);          9056
serv_addr.qos = QOS;                                9057

connect(fd, (struct sockaddr *) &serv_addr,         9058
        sizeof(serv_addr));

send and receive data to and from SERVER;           9059

close(fd);                                          9060
exit(0);                                            9061
```

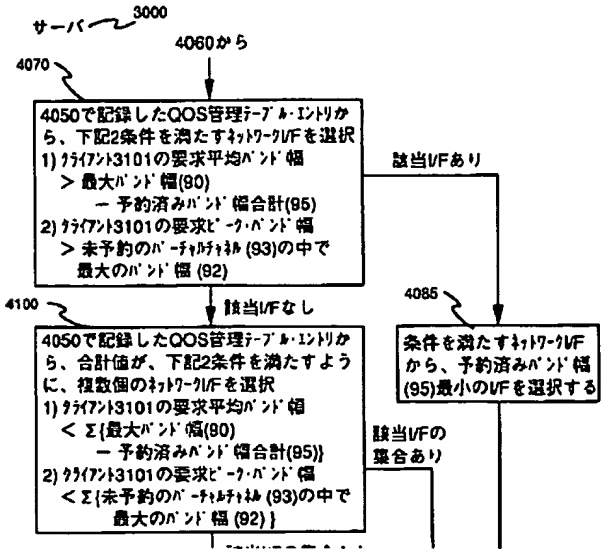
[Drawing 18]

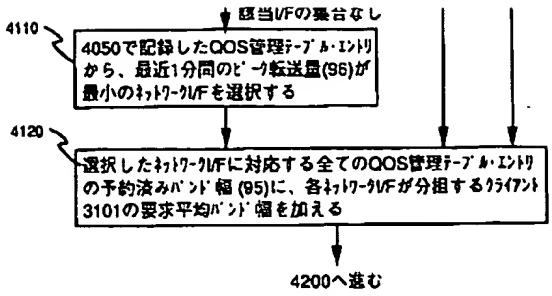
図１８



[Drawing 19]

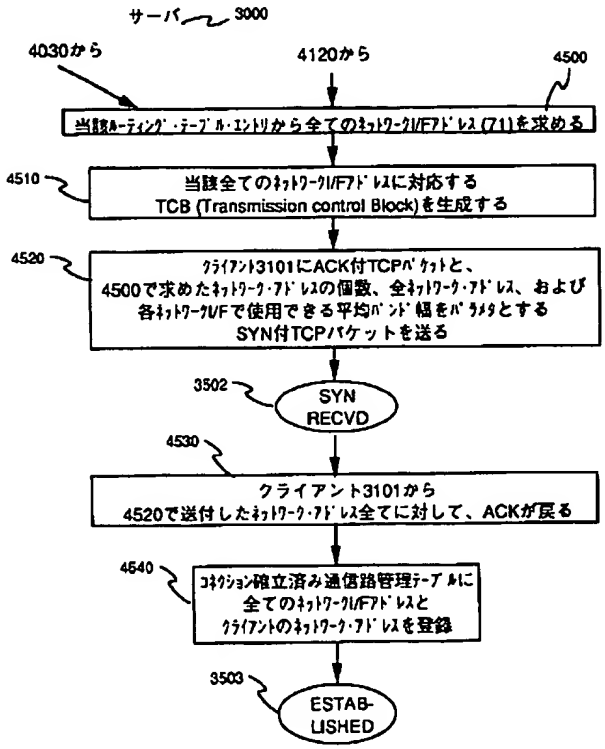
図１９





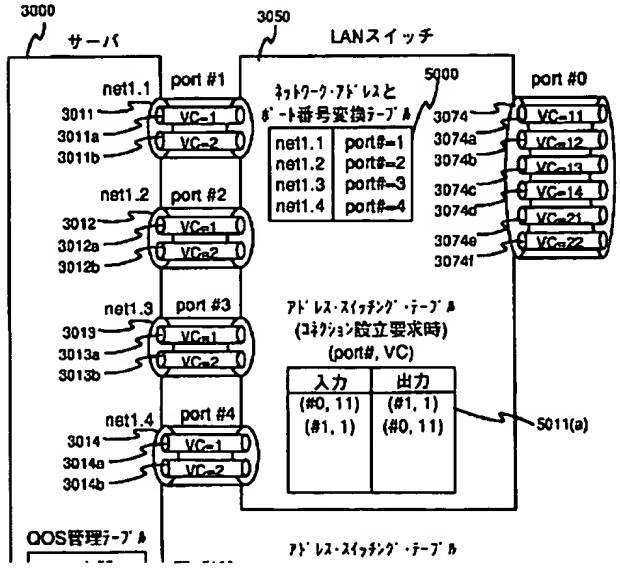
[Drawing 20]

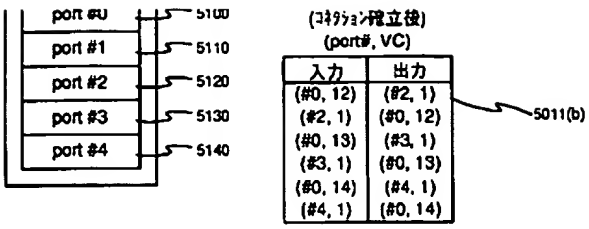
図２０



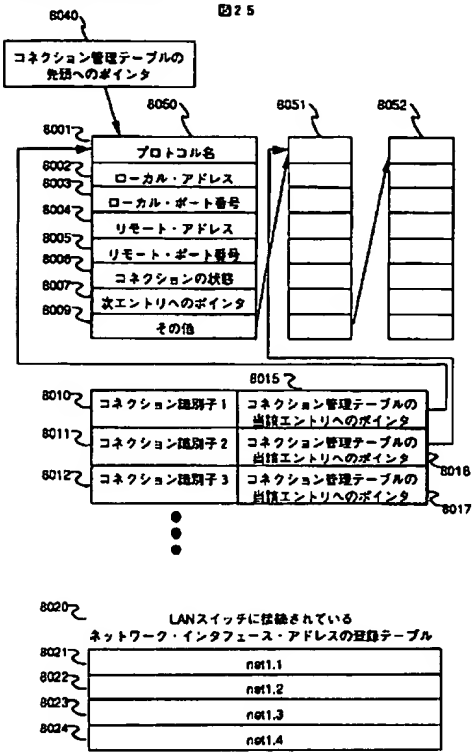
[Drawing 22]

図２２

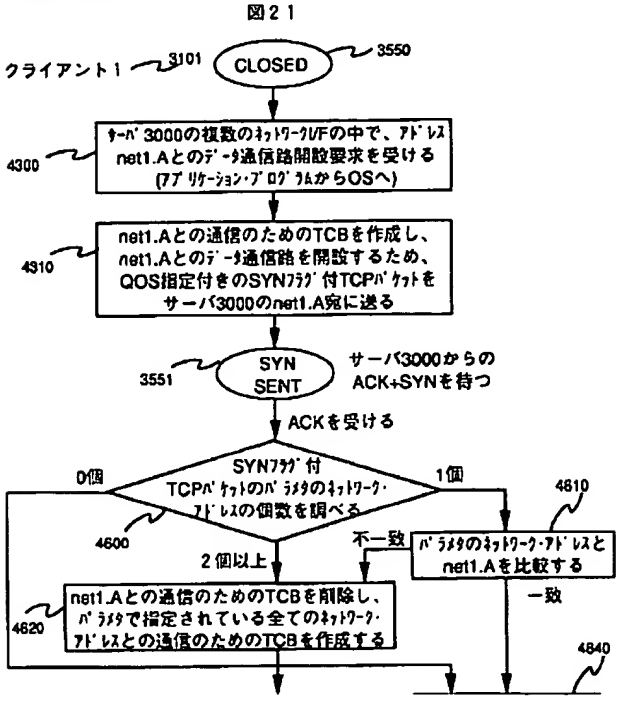


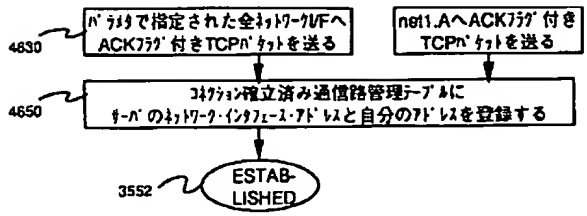


[Drawing 25]

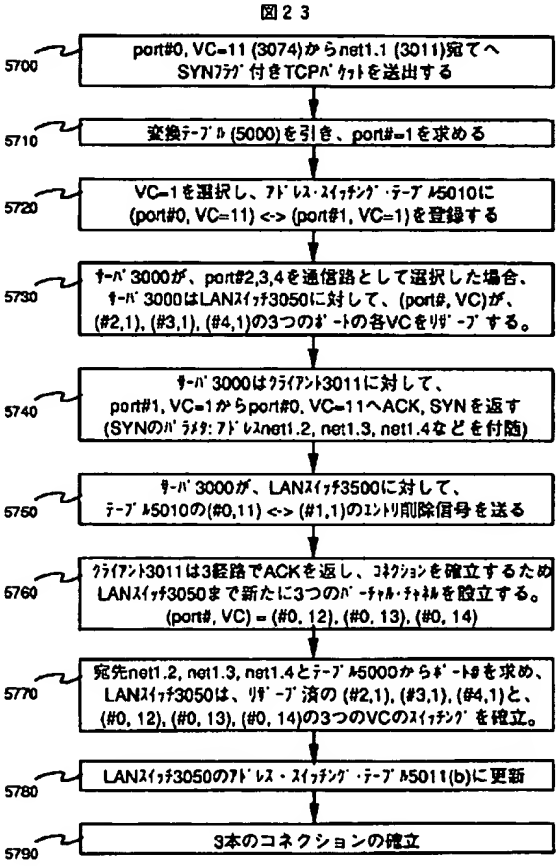


[Drawing 21]



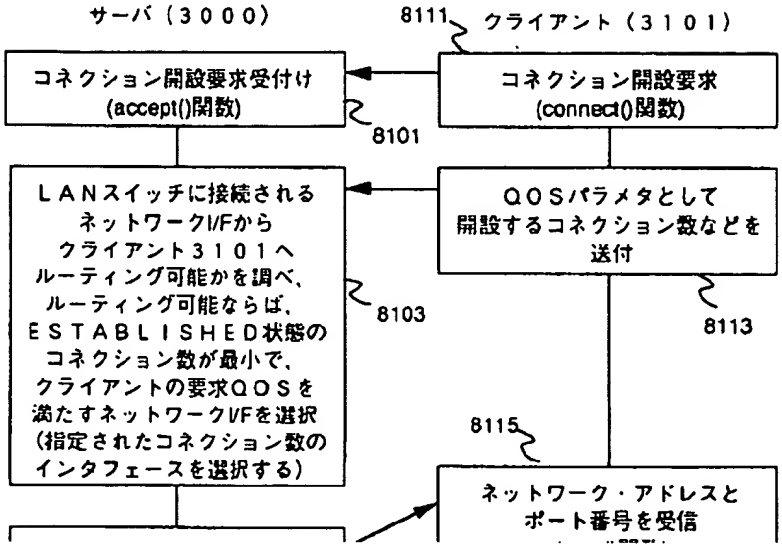


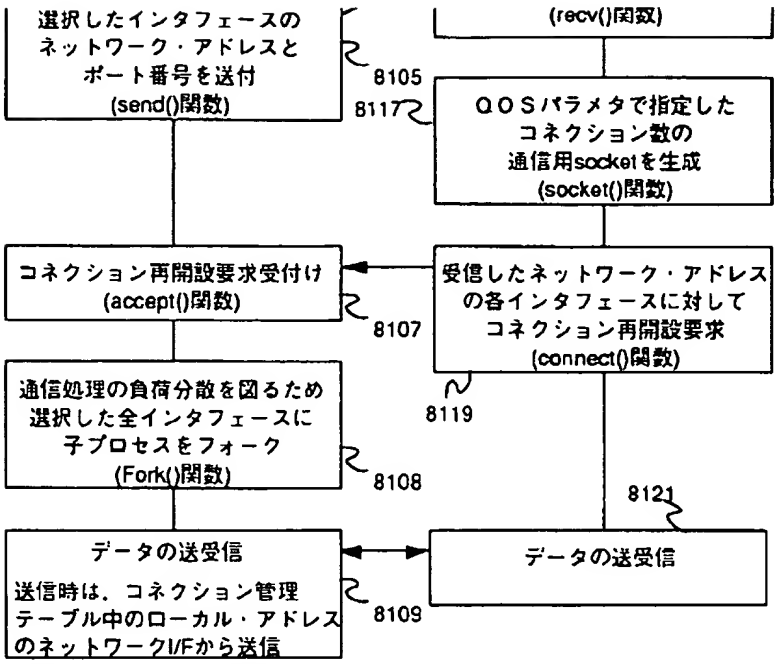
[Drawing 23]



[Drawing 26]

図２６





[redacted]

[Translation done.]